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Table of Contents, Volume 63

MARCH, 1954—NUMBER 1

JUNE, 1954—NUMBER 2

SEPTEMBER, 1954—NUMBER 3

DECEMBER, 1954—NUMBER 4

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I

BRONCHOGENIC CARCINOMA: ANALYSIS OF 201 PROVED CASES

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Primary cancer of the lung has long attracted much clinical and pathologic interest. According to Ewing,[1] it was Boyle, in 1810, who first vaguely described pulmonary cancer and Stokes, in 1842, who recognized several varieties of the disease. Jaccaud appears to have been the first to distinguish the disease from tuberculosis. By 1857, Ebermann had collected 72 cases, and Bennett, in 1872, presented a clinical analysis of 39 cases. In a report on 374 cases collected in 1912, Adler[2] wrote "primary neoplasms of the lung are among the rarest forms of the disease." Now, roughly 40 years later, bronchogenic carcinoma is second only to cancer of the stomach as a cause of death in the male population of the United States[3] and its incidence continues to increase more rapidly than that of any other malignant neoplasm.

A consideration of the death rate from pulmonary cancer per 100,000 population in the United States from 1920 to 1950 confirms

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this fact. These were reported as: 1.1 in 1920, 2.2 in 1930, 4.0 in 1940 and 12.2 in 1950. Thus, the death rate from this disease was 12 times greater in 1950 than it was in 1920. Moreover, from 1938 to 1950 the number of deaths has increased from 6732 to 18,313, or 172 per cent. In this same period the deaths from all malignant neoplasms increased only 41 per cent (from 149,214 to 210,733). The rate for 1950 represents 8.7 per cent of all cancer deaths in both sexes and 15.9 per cent of all cancer fatalities in males. Ochsner and associates[4] have predicted that if present trends continue, by 1970 annual deaths from cancer of the lung will reach approximately 47,000 or 18 per cent of all cancer deaths. Over twice as many patients with bronchogenic carcinoma as cancer of the stomach were admitted to Memorial Hospital in 1949, according to Watson.[5]

Study of the literature reveals a similar increase in the mortality from pulmonary cancer in foreign nations.[6-11] According to Doll and Hill[6] deaths fom pulmonary cancer in England and Wales numbered 13,233 in 1951 and showed an increase of 15 times from 1922 to 1947.

There has been much controversy as to whether this increase in incidence indicates that pulmonary carcinoma is becoming more common or whether it means that the condition is being more accurately diagnosed. That bronchogenic carcinoma has become a disease of primary importance and that the disease is increasing in absolute figures as well as in proportion to all other sites of cancer is now generally conceded by most observers, according to Clagett.[12]

The present study is concerned with a review of 201 cases of bronchogenic carcinoma proved at operation or autopsy in which bronchoscopic examination was performed between 1943 and 1953.

DISTRIBUTION ACCORDING TO SEX AND AGE

It is well known that bronchogenic carcinoma is primarily a disease of men. According to most reports the disease is encountered in men four or five times as often as in women. However, in the present series there were 175 men (87 per cent) and only 26 women (13 per cent), or a ratio of approximately seven to one.

Bronchogenic carcinoma is encountered primarily in patients in the fifth, sixth and seventh decades of life. In the present series, 93 per cent of the patients were between 40 and 69 years of age. The youngest was 31 and the oldest 73 years of age. Our "index of suspicion" for this disease should therefore be highest among men between 40 and 69 years of age.

ETIOLOGY

The etiology of bronchogenic carcinoma remains obscure although several possible etiologic factors have recently been incriminated. The smoking of tobacco, particularly cigarettes, as a factor responsible for the increase of bronchogenic carcinoma has led to considerable controversy in recent years. Wynder and Graham[13] believe that excessive and prolonged cigarette smoking is an important factor in the genesis of bronchogenic carcinoma. Of their 605 male patients with bronchial carcinoma 96 per cent had smoked excessively for over 20 years. Doll and Hill,[6] who made a complete investigation of tobacco as an etiologic factor in carcinoma of the lung, concluded that there is a real relationship between smoking and pulmonary cancer. However, this does not mean that tobacco smoke contributed to development of the disease in all cases or that it was the sole cause of the increased death rate in recent years. As Alvarez[14] has pointed out, not enough research has been done to prove that there are carcinogenic chemicals in the tars that form during the smoking of cigarettes. Perhaps the studies now being conducted by Hammond and Horn[15] will, in two or three years, clarify the relationship of tobacco smoking to the development of pulmonary cancer.

A fairly high percentage of women in whom bronchial cancer develops have adenocarcinoma, whereas only a small number have squamous cell or undifferentiated carcinoma. This has led Graham and associates,[16] Ochsner and co-workers[17] and others to believe that adenocarcinoma of the bronchus arises from an embryonic bronchial bud which has failed to develop normally and has remained dormant for years. They attribute the preponderance of squamous and undifferentiated carcinoma in men to greater exposure to carcinogenic factors in tobacco smoke, whereas the relatively equal incidence of adenocarcinoma between the sexes supports the contention that this type of tumor is not related to the smoking tobacco.

In the present series, 92.4 per cent of the patients smoked; 136 patients (67.6 per cent) were classed as "heavy" smokers, i.e., smoked 20 or more cigarettes daily or an equivalent amount of pipe or cigar tobacco. Most were cigarette smokers. Occupation, race and residence appeared to be insignificant factors.

That inhalation of radioactive dust may have some bearing on the etiology of pulmonary cancer has been suggested by Ackerman and DelRegato[10] in a report based on studios of cobalt miners in the Schneeburg district of Saxony, Germany and uranium miners in the Sudetenland who showed a high incidence of bronchogenic carcinoma. It is estimated that 50 per cent of the workers in the Sudet-

enland mines and 75 per cent of those in the Saxony mines were afflicted. Perry[9] suggested that industrial exposure to arsenic and certain other metallic substances may be associated with the etiology of pulmonary cancer. Arsenic is present in carcinogenically significant amounts in cigarettes, according to this author. Mason[8] was able to find no evidence that persons exposed to war gases in World War I had been unduly liable to cancer of the lung.

During the period of rapidly increasing incidence of bronchogenic carcinoma, the general population of the United States has been increasingly exposed to many noxious vapors and gases, foremost among them being automobile exhaust fumes. The increased use of the automobile with its attendant traffic congestion, as well as the growth and centralization of industry, may act as contributing factors in the genesis of cancer of the lung.

No significant correlation between urban or rural residence in the development of pulmonary cancer has been shown. The hereditary influence, prominent in experimental studies, has not been confirmed in the human.

In summary, there probably are multiple etiologic factors in cancer of the lung. It is possible that external irritation influences squamous cell and undifferentiated bronchogenic carcinoma and the statistical evidence of the relationship of these types of carcinoma to the prolonged use of cigarettes in excess cannot be denied. On the other hand, adenocarcinoma seems related more to congenital maldevelopment of cell structure. There is a possibility of viral etiology in the rare alveolar cell neoplasm, as indicated by animal study. There is a great need for further investigation into the etiology of this disease.

PATHOLOGY

Carcinoma of the lung may be pathologically classified as either an alveolar or bronchogenic neoplasm. According to Watson and Smith,[18] it was Malassez in 1876 who first described alveolar cell cancer of the lung. It probably comprises five per cent, or less, of primary pulmonary neoplasms, is of multicentric origin and arises from the alveolar sacs, according to Watson and Smith,[18] Moersch[19] and Ikeda.[20] No instance of alveolar cell tumor was encountered in the present series. Of the bronchogenic carcinomas, there are three principal varieties: the epidermoid or squamous cell tumors, the undifferentiated carcinomas and the adenocarcinomas.

From the clinical point of view, pulmonary cancer may be divided into two large groups: those found near the hilus involving

TABLE I.
APPARENT SITES OF ORIGIN OF BRONCHOGENIC CARCINOMA IN 201 PROVED CASES.

	CASES		PER CENT
Right		110	54.7
Upper lobe	54		
Middle lobe	3		
Lower lobe	45		
Main bronchus	8		
Left		91	45.3
Upper lobe	49		
Lower lobe	32		
Main bronchus	10		
Total		201	100.0

the larger bronchi, and those which appear in the periphery of the lung. Epidermoid and undifferentiated carcinomas usually arise in the main lobar or segmental branch bronchi and are usually found in the central portion of the lung. Adenocarcinoma tends to originate in the bronchi in a more peripheral location than the epidermoid tumor, is derived from the bronchial glands, and is believed to arise from embryonal bronchial buds which fail to develop normally.

In the present series of 201 patients, there were 91 instances of squamous cell or epidermoid carcinoma, 67 cases of undifferentiated carcinoma and 43 patients with adenocarcinoma. As in other reported series, the squamous cell and undifferentiated carcinomas comprised over three-fourths of the group, with adenocarcinoma constituting about 20 per cent of the total number. It is interesting to note the distribution of the type of lesion in the two sexes. Of 91 patients with squamous cell (epidermoid) carcinoma, 97 per cent were men and only 3 per cent were women. Practically the same is true for the 67 patients with undifferentiated carcinomas, 88 per cent occurring in men and 12 per cent in women. On the other hand, 35 per cent of the 43 patients with adenocarcinoma were women and 65 per cent were men. The right lung was involved slightly more often than the left. The distribution of apparent sites of origin can be seen in Table I.

TABLE II.
INITIAL CLINICAL MANIFESTATION IN 201 PROVED CASES OF BRONCHOGENIC CARCINOMA.

CLINICAL MANIFESTATIONS	CASES
Cough	71
Thoracic discomfort or pain	36
Shortness of breath	19
"Cold"	16
Pneumonia	15
Blood spitting	13
Influenza	11
Fatigue and weakness	8
Wheezing	3
Fever	3
Loss of weight	2
Suspected tuberculosis	2
Night sweats	1
Positive roentgenogram	1
Total	201

Slightly over half the patients had lesions in the upper lobes, a factor which significantly affects the ability of the bronchoscopist, even though aided by the retrograde bronchial telescope, to secure a positive biopsy. Of the 54 patients with right upper lobe carcinoma, 24 had squamous cell type, 18 undifferentiated carcinoma and 12 adenocarcinoma. Of three cases occurring in the right middle lobe, one was of squamous cell type, and two were undifferentiated. In 45 cases in which the right lower lobe was involved, 15 were of squamous cell type, 17 were undifferentiated and 13 were adenocarcinoma. Of the 49 cases found in the left upper lobe, 22 were of squamous cell type, 13 undifferentiated and 14 adenocarcinoma. Of the 32 instances occurring in the left lower lobe, there were 18 squamous cell, 11 undifferentiated and 3 adenocarcinomas.

Only eight of the primary carcinomas were in the right main bronchus and ten in the left main bronchus. Of the eight carcinomas

found in the right main bronchus, four were squamous cell and four undifferentiated. Of the ten carcinomas found in the left main bronchus, seven were of squamous cell type, two were undifferentiated and one was adenocarcinoma.

The spread of bronchogenic carcinoma is primarily by way of the lymphatics but cells may be transplanted in pleural exudate or by extension, particularly to the pericardium and superior vena cava. Metastasis occurs first to the peribronchial lymph nodes, later to the hilar and mediastinal nodes. Malignant cells may then reach the supraclavicular or axillary nodes by retrograde passage, or they may reach the venous circulation and be carried to other portions of the lungs or into the systemic circulation. The brain is a common site of systemic metastasis. It is also not uncommon for bronchogenic carcinoma to metastasize to the skin.

SYMPTOMS

There are no symptoms pathognomonic of carcinoma of the lung. Any of the symptoms of pulmonary cancer can be produced by a wide variety of pulmonic diseases. The onset of bronchogenic carcinoma is insidious and, since it occurs with such preponderance in persons who have a chronic cough usually attributed to smoking, the patient as well as his physician often is prone to attach little significance to this symptom. Overholt and Schmidt[21] and Paulson and Shaw[22] have called attention to the "silent phase" of bronchial carcinoma when there are no symptoms until the mucosa is initiated or ruptured. Almost all the patients in the present series had an initial complaint referable to the lower respiratory tract (Table II).

The commonest initial symptom was cough, which occurred in 35 per cent of cases. Typically, the cough at first was dry and irritating but later became productive. Thoracic discomfort or pain was the initial complaint in 36 patients. Often the earliest manifestation was vague heaviness or constriction in the chest not described as pain until later. Pleurisy usually developed still later. Shortness of breath (19 cases) and wheezing (three cases) usually began as a sensation of "not being able to take a full inspiration," later changing to dyspnea on exertion. Hemoptysis was the initial symptom in only 13 patients. Eight patients complained initially of fatigue and weakness; three had fever and two noted that they were starting to lose weight. In four patients the initial symptoms were similar to those of brain tumor. One patient in the series was unaware that he had a thoracic disease until he had routine roentgenograms of the chest.

TABLE III.
PRESENTING SYMPTOMS IN 201 PROVED CASES OF BRONCHOGENIC CARCINOMA.

SYMPTOMS	CASES	PER CENT
Cough	180	90
Thoracic pain	120	60
Hemoptysis	95	47
Loss of weight	84	42
Dyspnea	67	33
Sputum	66	32
Wheezing	38	19
Fatigue and weakness	38	19
Fever	29	14
Hoarseness	10	5
Night sweats	5	2.5
Symptoms referable to central nervous system	4	2

Forty-two patients (20 per cent) gave a history of persistence of symptoms after a chest "cold," influenza or pneumonia. These patients almost always consulted their family physician, who usually treated them symptomatically for long periods until more grave symptoms appeared. This would indicate that the medical profession in general does not frequently enough consider bronchogenic carcinoma a possibility in men over 40 years of age with a lingering cough, in whom some form of thoracic discomfort develops or whose roentgenograms show "unresolved pneumonia," "atypical pneumonia," "viral pneumonia" or "nonspecific pneumonitis" following an infection of the lower respiratory tract.

Table III lists in order of frequency the outstanding symptoms on admission to the hospital. They differ but little from those reported by others.[8, 24-27] The clinical picture presented by the patient when admitted for definitive diagnosis and treatment depends upon the site and size of the neoplasm, the stage and speed of its development, the presence or absence of metastases, the secondary inflammatory changes and the general physical status. The cardinal symptoms of pulmonary carcinoma are cough with or with-

out expectoration, thoracic pain, hemoptysis and dyspnea. These symptoms are due to local pressure and destructive effects of the growth, bronchial obstruction with resultant distal inflammatory changes in the lung and metastatic processes away from the original site of the tumor. Pain frequently accompanies the pneumonitis resulting from endobronchial obstruction, but when it is a late symptom, it signifies pleural, thoracic wall or mediastinal involvement. Loss of weight, usually considered a late manifestation of the disease, occurs earlier and more frequently than was once believed. Hoarseness indicates recurrent laryngeal nerve paresis or paralysis due to mediastinal extension.

PHYSICAL SIGNS

Early bronchogenic carcinoma produces few physical signs. Small, peripheral neoplasms may remain silent until metastases occur. In general, bronchogenic carcinoma produces signs of complete or partial endobronchial obstruction, ulceration, infiltration and secondary infection as outlined by Jackson and Jackson.[28] Therefore, obstructive or compensatory emphysema, atelectasis, asthmatoid wheezing, lobar pneumonia, localized pneumonitis or effusion are among the thoracic findings warranting a more complete investigation. Tracheal deviation, retraction of the chest, limitation of expansion, dulness or flatness on percussion, elevation of the diaphragm and suppressed or absent breath sounds are commonly found when obstruction is complete. Metastases are indicated by enlargement of cervical, supraclavicular or axillary nodes on the affected side, bloody pleural effusion, paralysis of the diaphragm or vocal cord, Horner's syndrome, or signs of involvement of bone, brain, skin, liver or adrenal glands.

DIAGNOSIS

The diagnosis of bronchogenic carcinoma is frequently delayed several valuable months. In fact, in this series, the average delay was 7.8 months before positive diagnosis. The average delay in diagnosis after the patient first sought medical consultation was 3.1 months. Less than 20 per cent of the patients had symptoms of two months or less. It is obvious that the benefits from advances in therapy can be realized only through earlier recognition of the disease.

The roentgenogram of the chest is the most valuable single means of obtaining an early presumptive diagnosis of bronchogenic carcinoma. It will indicate pathologic alterations in the chest in a high percentage of cases; in the present series roentgenography led to a suspicion of bronchogenic carcinoma in 191 cases or 95 per cent

TABLE IV.
ROENTGENOLOGIC OBSERVATIONS IN 201 PROVED CASES OF BRONCHOGENIC CARCINOMA.

	CASES
Hilar Mass	66
Atelectasis (massive or segmental)	59
Infiltration (central or peripheral)	61
Effusion	5
Suppurative lesion	4
Negative	5
No report	1

of the series. Thus, the routine use of roentgenography of the chest every six months in men over 40 years of age who smoke should lead to detection of many cases of bronchial carcinoma before symptoms occur. The importance of the lateral film, in addition to the routine postero-anterior view, cannot be too strongly emphasized.

Although an occasional instance of early bronchogenic carcinoma is detected roentgenographically as obstructive emphysema due to "check valve" obstruction of the bronchus to expired air, the majority of cases show varying degrees of atelectasis, hilar mass, or infiltration of central or peripheral type (Table IV). Pleural effusion is usually an indication of advanced disease. Cancer of the lung occasionally is confused with tuberculosis or pulmonary abscess. According to Poppe[29] virus pneumonia, unresolved pneumonia, segmental atelectasis and pneumonitis are the most frequent disguises of malignant endobronchial obstruction.

As pointed out by Paulson and Shaw,[22] tumors located in the smaller bronchi tend to cause rapid obstruction and produce a circumscribed, round or oval shadow on the roentgenogram. They may later necrose, leading to a diagnosis of pulmonary abscess, the true etiology of which is unsuspected. Hood and associates[30] studied 156 patients whose roentgenograms showed solitary circumscribed lesions of the lung, 35 per cent of which were subsequently proved to be malignant; 16 per cent of the cases showed primary bronchogenic carcinoma. In another report[31] approximately 50 per cent of solitary lesions in the pulmonary parenchyma discovered on mass chest

TABLE V.
SITES YIELDING POSITIVE RESULTS OF BRONCHOSCOPIC BIOPSY IN 83 CASES.

Right intermediate bronchus	18
Left lower lobe bronchus	15
Right lower lobe bronchus	13
Left main bronchus	10
Right upper lobe bronchus	9
Right main bronchus	8
Trachea	4
Left upper lobe bronchus	3
Right middle lobe bronchus	2
Carina	1
Total	83

surveys were either primary or metastatic malignant tumors. In this instance, primary cancer of the lung predominated over the metastatic lesions in a ratio of nearly 15:1. Tuberculoma accounted for about 25 per cent of the cases, with the remaining 25 per cent consisting of other inflammatory granulomas, cysts, myofibromas and hamartomas.

Bronchography is of value in demonstrating bronchial obstruction in segmental branches and the upper lobes and frequently reveals associated bronchiectasis or pulmonary abscess.

Bronchoscopy should be performed in patients suspected of having bronchogenic carcinoma in order to establish the diagnosis by visualization of the lesion and forceps biopsy, as well as to aid in determing operability based on the local extent of the lesion and the condition of the bronchi, carina and trachea. It has been pointed out by Moyer and Ackerman[32] that inasmuch as bronchogenic tumors are only rarely demonstrated in the absence of roentgenographic evidence of roentgenographic evidence, bronchoscopy is more helpful in confirming the diagnosis than in demonstrating an undiagnosed lesion. Another important function of bronchoscopy is collection of bronchial secretions by aspiration or broncholavage for cytologic study by the Papanicolaou staining technique as reported by Herbut and Clerf.[33]

The bronchoscopic picture of bronchogenic carcinoma varies greatly. Frequently, the lesion appears soft, red and nodular, filling a major or segmental branch bronchus. Such a lesion may be covered with a necrotic exudate. Other tumors have a polypoid appearance. Often peripheral carcinomas produce stenotic changes in the lobar or main bronchi which prevent the bronchoscopist from visualizing the neoplasm directly. These stenotic areas frequently show infiltration by carcinoma, however, so biopsy is advisable.[34] Tracheal infiltration, by extension from mediastinal lymph nodes, is seen in certain instances. The bronchoscopic demonstration of anatomicopathologic changes indicative of bronchogenic carcinoma or its metastasis, when correlated with the roentgenologic and clinical observations, comprises important suggestive evidence in the absence of a positive biopsy report or negative cytologic report of the bronchial aspirate. Changes which may be noted are fixation and rigidity of the carina, tracheal compression or displacement, bronchial compression or distortion by an outlying mass or laryngeal nerve paralysis. Of the 201 patients in the present series 80 or 39.8 per cent had anatomicopathologic changes which supported the clinical and roentgenographic diagnosis of bronchial cancer.

A positive diagnosis of bronchogenic carcinoma was made by bronchoscopic biopsy in 83 (41.2 per cent) of the 201 subsequently proved cases in this series. The areas in the tracheobronchial tree which yielded a positive diagnosis are listed in Table V. Reports[24, 35-39] appearing in the literature a decade ago often cited incidences of positive bronchoscopic biopsy ranging from 60 to 78 per cent in patients with bronchogenic carcinoma but more recent reports[4, 26, 29, 40-42] indicate that these figures are much lower, ranging from 24 to 50 per cent. This reduction in percentage of positive bronchoscopic biopsy is undoubtedly due to the fact that patients are being examined earlier in the course of their disease. However, it is deplorable that so many non-resectable cases are still seen today. As stated by Clerf and associates,[40] "the percentage of positive bronchoscopic biopsy bears a direct ratio to the percentage of inoperable cases."

Collection of bronchial secretions by bronchoscopic aspiration for cytologic study is a valuable diagnostic procedure. It is based on the fact that desquamation of carcinoma cells takes place from the free surface of the tumor and, since most primary carcinomas of the lung communicate with a bronchus or bronchiole, cells are likely to find their way into a major bronchus owing to the cephalad current of the bronchial secretions. As Moersch[19] has emphasized, experience is important for interpretation of cytologic specimens and even

in the hands of the most skilled pathologists an element of error in diagnosis remains. Papanicolaou and Koprowska[43] reported a case of carcinoma in situ involving the right lower lobe bronchus in which repeated bronchoscopic examinations yielded negative results but four sputum specimens and six broncholavage specimens contained malignant cells. After the patient died of other causes, autopsy showed no gross bronchopulmonary evidence of carcinoma but serial microscopic sections of the right lower lobe bronchus demonstrated carcinoma in situ.

In 39 cases of proved primary cancer of the lung in the present series, cytologic examination indicated cancer in 14, or nearly 36 per cent. It is realized that this incidence of positive diagnosis by cytology is not a high proportion of the entire series, but this may be explained by the fact that the method only fairly recently has been adopted by pathologists and it is a tedious laboratory procedure. Cytologic examination of bronchial secretions has been employed only in the later years of the series and the more recent instances have a much higher percentage of positive diagnosis than the earlier cases. In addition, specimens during the past five years of the series were distributed among three pathologists, all of whom adopt slightly different criteria for a positive cytologic diagnosis of malignancy.

Aspiration biopsy and thoracoscopy were not used in this series. The pleural fluid was found to contain malignant cells in four instances.

In 31 patients (15.4 per cent) bronchoscopy did not result in positive biopsy; no anatomicopathologic changes indicative of bronchial carcinoma were observed and cytologic examination of bronchial secretions or broncholavage aspirate yielded negative results. These patients all had exploratory thoracotomies which revealed the presence of bronchogenic carcinoma.

Early exploratory thoracotomy has been advocated for all patients with clinical and roentgenographic evidence of pulmonary cancer even though the bronchoscopic and cytologic examination were negative.[4, 12, 19, 30, 44] In a high percentage of such patients, especially those with solitary circumscribed lesions of the lung, primary pulmonary cancer is discovered at exploratory thoracotomy. Most of the benign lesions encountered on thoracic exploration are best treated by surgical excision. Most reports emphasize the necessity of excising an indeterminate mass in the lung since the mortality rate for thoracotomy is low.

TREATMENT

Except for palliative removal of obstructing endobronchial carcinoma in inoperable patients or dilatation of stenotic bronchi in such instances to alleviate dyspnea and facilitate drainage of a distal suppurative process, bronchoscopy has little to offer by way of treatment in bronchogenic carcinoma. The treatment of bronchogenic carcinoma is pneumonectomy with complete removal of mediastinal lymph nodes. It must be realized, however, that little future improvement in survival rates after excision can be expected unless the public and the medical profession are made more conscious of the frequent occurrence of bronchogenic carcinoma in men over 40 years of age with cough and mild thoracic discomfort. Only in this way can there be any drastic reduction in the present delay in diagnosis after the onset of symptoms.

SUMMARY AND CONCLUSION

The incidence of bronchogenic cancer in the male population of the United States is showing a more rapid increase than that of any other malignant neoplasm.

Bronchogenic carcinoma occurs primarily in men in the fifth, sixth and seventh decades of life. In the present series 87 per cent were men.

Whereas only a small percentage of women in this series had squamous cell or undifferentiated bronchogenic carcinoma, 35 per cent of the 43 patients with adenocarcinoma were women.

The excessive use of tobacco may be an etiologic factor in the genesis of bronchial carcinoma. Other possible factors are the inhalation of radioactive dust, industrial exposure to arsenicals and other chemicals and atmospheric pollution by industrial fumes and automobile exhaust gases; 92.4 per cent of the patients in this series smoked tobacco and 67.6 per cent of the total number were excessive smokers.

Bronchogenic carcinoma accounts for most cases of pulmonary cancer, alveolar cell tumors occurring in less than 5 per cent of patients. In this series there were 91 instances of squamous cell type carcinoma, 67 cases of undifferentiated carcinoma and 43 patients with adenocarcinoma.

The cardinal symptoms of bronchogenic carcinoma in order of frequency in this series were cough, thoracic discomfort or pain, hemoptysis, loss of weight and dyspnea. The average duration of symptoms from onset to positive diagnosis was nearly eight months.

The average delay from the first medical consultation to positive diagnosis was over three months.

The physical signs of bronchogenic carcinoma are those of any endobronchial obstruction in most instances.

The roentgenogram of the chest is the most valuable single means of obtaining a presumptive diagnosis of pulmonary cancer. In this series, 95 per cent of patients were suspected by the roentgenologist as having bronchogenic carcinoma.

Bronchoscopy is of value in establishing the diagnosis of bronchogenic carcinoma by visualization and biopsy of the lesion and by permitting removal of bronchial secretions for cytologic examination. It is also an aid in determining operability based on the presence or absence of anatomicopathologic changes in the tracheobronchial tree typical of bronchial carcinoma. In this series, the diagnosis was made by bronchoscopic biopsy in 41.2 per cent of patients subsequently proved to have bronchogenic carcinoma and in 39.8 per cent bronchoscopy demonstrated anatomicopathologic changes typical of bronchogenic carcinoma. Cytologic study of bronchial secretions was done in 39 patients, in 36 per cent of whom the examination demonstrated the presence of malignant cells. In 15.4 per cent of all patients, bronchoscopy and cytology yielded negative signs of malignancy.

In patients in whom the diagnosis of bronchogenic carcinoma cannot be ruled out clinically and especially in those with roentgenographic evidence of solitary circumscribed pulmonary masses, early exploratory thoracotomy is indicated.

The treatment of bronchogenic carcinoma is total pneumonectomy with complete removal of the mediastinal nodes.

There is a need for further education of the public and the medical profession in the early diagnosis of cancer of the lung.

765 Brotherhood Building.

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II

OBJECTIVE SKIN RESISTANCE AUDIOMETRY

THE ELECTRO-AUDIOGRAM (EAG)

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THE MEASUREMENT OF HUMAN HEARING

1. *Changing concepts in audiometry.* The popularization of current "audiometry" has been achieved at the sacrifice of certain fundamentals in the measurement of that complex sensory function called hearing. Too often the measurement of hearing simply implies pure tone threshold audiometry very frequently in terms of air conduction alone.

It is becoming quite clear now that this is an inadequate concept. The true measurement of human hearing involves quantitative and qualitative evaluation of the physiologic integrity of the entire auditory system including the cortex.

It became obvious not too long ago that the measurement of the hearing function, clinically, called for more information than could be obtained by conventional simple pure tone audiometry. Innumerable examples of inconsistencies between the pure tone audiometric record and the actual demonstration of hearing by the patient prompted the elaboration of other types of hearing tests.

In order to obtain a more complete picture of the hearing status of a patient, it is desirable to ascertain the following facts:

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1. The threshold for selected pure tones within the aural spectrum by air conduction and bone conduction.
2. The over-all threshold for human speech (spondee words).
3. The discrimination of human speech (PB lists for intelligibility.
4. The presence or absence of recruitment.
5. The characteristics of tinnitus, if present.

2. *The Subjective Nature of all Hearing Measurements.* The estimation of the efficiency of a sensory system is usually based upon subjective responses. Thus all conventional audiometry falls into that group of psychological tests which must be considered entirely subjective in nature. This puts the cortex in an important role within the entire response mechanism. Inasmuch as subjective responses depend upon cortical interpretations and motor executions for response evaluations, any test in the ordinary audiometric armamentarium is no better than the cortical cooperation involved. This fact is extremely important in the testing of hearing and is frequently ignored or given inadequate weight in the final appraisal of an audiogram.

In most normal adult audiometry the cortical component is not a serious matter and excellent cooperation can be obtained. However, there is a small but very important group of patients in whom the cortical component becomes the major issue. This is particularly true in young children and in individuals with superimposed neurologic or psychologic disease. Accordingly, a search for an objective method of audiometry has existed for some time. Within recent years a method of "objective audiometry" has been proposed using the technique of the psychogalvanic skin resistance response.

3. *Objective audiometric techniques—are they truly objective?* During the past few years several approaches to objective audiometry have been suggested. The most popular of these tests is the psychogalvanic skin resistance technic. The use of the electro-encephalographic arousal response has also been suggested as a method of objective audiometry.

It is difficult to apply the term "objective audiometry" to both of these test techniques. The only truly objective test of hearing is the direct recording of cochlear microphonics or action potentials from direct electrode applications to the inner ear or from the eighth nerve as responses to acoustic stimuli delivered to the external ear. Such techniques have been successfully accomplished in animals and experimentally in humans, but to date no practical method of direct

objective recording of either cochlear microphonics or action potentials has been devised for the human.

The skin resistance audiometry described in this paper has been termed objective in nature but it is actually the objective recording of a conditioned reflex response which utilizes a conditioned reflex arc, so that the objectivity is not a function of the direct electronic sequelae within the cochlea following acoustic stimulation of the external ear. Thus, while the skin resistance technique might well be defined as non-subjective, it is not truly objective.

THE DEVELOPMENT OF PSYCHOGALVANIC SKIN RESISTANCE AUDIOMETRY

Electrodermal measurements of skin resistance have been used extensively in the study of psychologic and physiologic phenomena. Many investigators including McClendon ('30), Landis ('32), Richter and Whelan,[25] Norton ('52) and Grings,[12] have been concerned with the development and validity of this test. Bordley and Hardy ('48) applied this technic to audiometric testing.

The electrical resistance of the skin varies directly with various emotional and physiological changes occurring within the body. The unit of measurement of electrical resistance is the ohm and this may be determined by measuring the passage of a minute amount of direct current between two electrodes placed on the skin. The conductivity of the skin between the electrodes varies with the skin resistance and this is modified by a minute amount of sweat elaborated beneath the electrodes, thus changing the conductivity at these points. The elaboration of this sweat beneath the electrodes is effected by the autonomic nervous system which in turn may be affected by a variety of stimuli such as pain produced by electrical currents, emotional stimuli, sounds of varying pitch and intensity, and others.

Apparatus to make records of these measurements of skin resistance changes has been utilized for years. A simple, practical device was developed by Richter and Whelan[23] and Richter, Woodruff and Eaton.[24] Dr. Curt Richter of Johns Hopkins has utilized this equipment and technic since 1922 in skin resistance testing. A direct current amplifier and a 5 milliampere ink recording ammeter is used. A wheatstone bridge indicates the small fluctuations in current flow though the patient. The small current flow, usually 2 to 20 microamperes between the two electrodes is adequate upon amplification to deflect the ink writer for permanent recording and subsequent study.

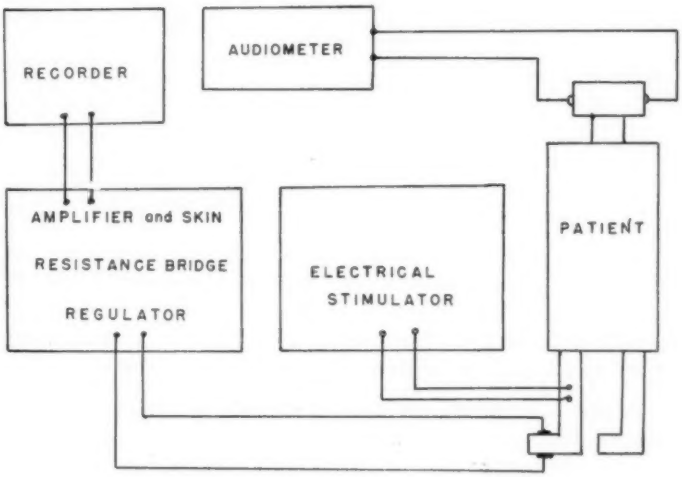


Fig. 1.—Electroaudiogram set-up.

Bordley and Hardy[2] have pioneered in adapting this technique of "psychogalvanic skin resistance" to audiometric testing and have achieved considerable success with it. Their technique utilized the same equipment used by Richter with the addition of a standard pure tone audiometer and an electric shocking device. A conditioned reflex of the Pavlovian type was set up after conditioning with a pure tone—followed within four or five seconds by a shock stimulus. The electrical shock stimulus was discontinued when a conditioned response to the sound stimulus had been achieved. A drop in skin resistance occurred between the electrodes due to the stimulation of the autonomic nervous system and secretion of sweat beneath the electrodes.

The skin resistance drop occurred within 1.5-2 seconds after the sound stimulus. The intensity of the sound was gradually diminished until threshold was reached. At threshold intensities usually no change in skin resistance occurred after sound stimulus. The sound spectrum was then explored since "a patient conditioned to one tone is thereafter conditioned to all tones audible to that individual" (according to Bordley and Hardy). Recent personal communication from W. W. Grings indicates that this not always true. Bordley and Hardy also found considerable variation in the strength

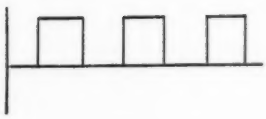


Fig. 2.—Galvanic current.

Fig. 3.—Faradic current.

of shock required for different subjects and reinforcement of the shock with increased intensity was necessary during the test. The skin resistance response which usually occurred about 1.5 seconds following the sound was characterized by a break downward in the skin resistance and two definite breaks on the graphic record.

Bordley and Hardy feel that this technique "is probably a valid functional measurement of the peripheral auditory mechanism," and is "of special usefulness in diagnostic work with very young children and adults who will not or cannot respond to subjective techniques." They do feel that some difficulties still exist and that this is not the "definitive answer to the problem of objective audiometry."

THE ELECTRO-AUDIOGRAM (EAG)

A. *Terminology.* The term electro-audiogram has been applied by us to this method of audiometry for simplification of terminology. Objective measurements are recorded of conditioned physiological changes, i.e., skin resistance changes induced by sound stimuli. These changes, electrical in nature, reflect the response of the individual to sound stimuli above threshold level. The Feré effect which is utilized in this test requires the passage of a direct current between the two electrodes and the measurement of the differences in resistance that occur. The Tarchanow effect which is the change in electrical potential between two electrodes on the skin may also be used. It may also be elicited by sounds and be directly related to the stimulus. It is therefore felt that a more general term indicative of the electrical nature of the test should be employed. The "electro-audiogram" or "EAG" is a term similar clinically to the terms electrocardiography (ECG) and electroencephalography (EEG). We realize however that the term is not a true "electrical audiogram" such as can only be obtained from a direct cochlear electrode. It is offered purely for simplified clinical usage.

The psychogalvanic skin resistance (PGSR) technique as developed by Bordley and Hardy has been utilized by us with several

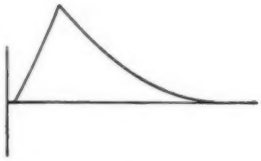


Fig. 4.—Condenser current.

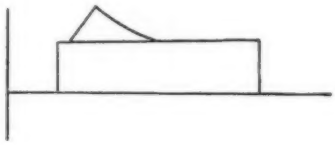


Fig. 5.—Condenser and filtered galvanic.

modifications introduced to adapt it to our needs. This report is concerned with our modifications and an evaluation of some of our results.

B. *Equipment.* The equipment required depends upon the variables that are to be tested. A source of electrical shock stimulation and the associated equipment to pick up the response from the patient and pass it through an appropriate amplifier into a recorder is needed (Fig. 1). Equipment with which to carry on pure tone, bone, air and free field testing is also required.

The question of the relative value of several types of electrical stimuli arose early in our testing program. In some of the tests made by us it was found that the galvanic and faradic types of stimuli were not tolerated very well by the young child (Fig. 2 and 3).

Upon repeated stimulation by these painful shocks the young patient may become apprehensive and emotionally upset so that an accurate recording cannot be obtained. On several occasions the testing could not be continued. Tests were then carried on utilizing a highly filtered, relatively ripple free galvanic stimulus. This was tolerated to a greater degree.

Condenser discharge currents were tried and tolerated very well (Fig. 4). Condenser discharge superimposed on galvanic current was also tolerated well (Fig. 5). This type of stimulus is relatively nonpainful. Conditioned responses are obtained that seem to have a direct correlation with the intensity of the stimulus.

A stimulator designed to produce the various types of current indicated was developed and found to be stable and provide an adequate range for all patients tested (Fig. 6). A microswitch mounted on the shock key closed a circuit which caused the pen to be deflected, thus indicating the timing sequence of stimuli.

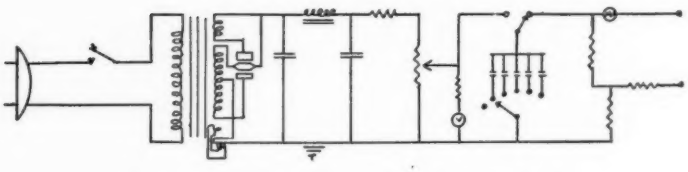


Fig. 6.—Electronic shock stimulator-current design.

The stimulating and pick-up electrodes consist of two pairs of electrodes; one pair are zinc discs approximately ½ inch in diameter and ⅛ inch in thickness and the other pair rectangular, approximately ¾ inch long by ½ inch wide and also ⅛ inch thick.

The skin resistance is measured by means of a decade type resistance or ohmmeter and the changes or fluctuations in skin resistance then pass through a wheatstone bridge (Fig. 7). The output of the bridge is then passed by appropriate switching into either a meter to assist in visually balancing the bridge or into the paper disc recorder. A Wallace and Tiernan 0-5 ma recorder is used and a circular concentric record obtained. Pure tone air and bone conduction and free field tests can be recorded on a single disc. The recording paper discs may be easily replaced during the course of a test, should more than one disc be required.

This circular graph type of record is preferable to the strip type not only because of the ease in reading the entire record but also because of the length of recording it makes possible. The rotation of the paper disc is slow so that recordings of one-and-one-half-hour duration can be made on a single disc. (Such lengthy test sessions are recommended). The base line is set at the periphery of the disc and the pen deflected toward the center of the disc in response to a stimulus. The deflection of the pen is limited by increasing or decreasing the sensitivity of the amplifier. The recording forms a spiral record on the disc, the record starting at the periphery and gradually moving toward the center of the disc. Notations regarding the sound frequency and intensity are entered directly on the recording as the test proceeds. An additional microswitch relay mounted on the interrupter switch of the audiometer also causes a deflection of the pen at the onset of the sound stimulus and maintains the deflection of the pen until the sound stimulus ends. The pen then drops back to the base line and is again reflected as the physiological response occurs.

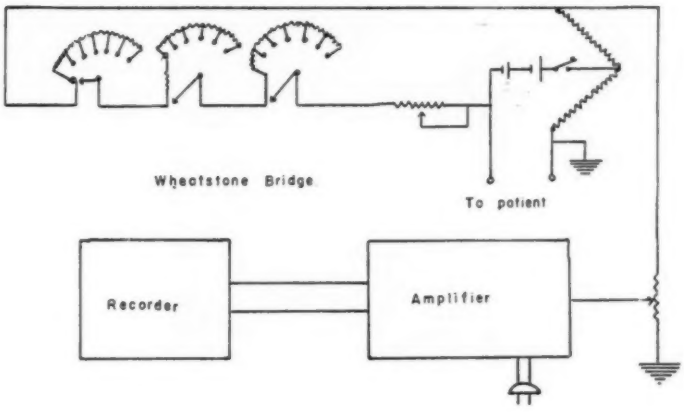


Fig. 7.—Wheatstone bridge-amplifier and recorder.

C. *Technique.* A series of approximately 150 patients have been tested and data obtained to evaluate this technique.

The leads are four conductor flexible stranded wire similar to the unshielded type used in telephones. The zinc electrodes are mounted as pairs in a standard rubber electrocardiograph electrode band and positioned on the leg and foot.

The stimulating electrodes are placed on the medial aspect of the leg, preferably on the fleshy portion of the soleus or gastrocnemius muscles. This position avoids the major nerves and produces no apparent muscle contraction or discomfort to the patient.

The pick-up pair of zinc electrodes are placed one on the plantar and the other on the dorsal aspect of the foot. The same electrode placement is followed in all tests. Electrocardiograph paste is used to provide adequate contact. Moderate pressure on the skin is desirable in order to prevent variations in skin resistance and conduction.

After application of the electrodes the adult patient is then permitted to read. The young child is allowed to play at a small table with building blocks, toys, etc. The conducting leads which are twelve feet long permit freedom of motion of the patient during testing. The skin resistance is obtained at this time and the bridge balanced for the patient being tested. A quiet two-room setup is used (Fig. 8). Observation of the test patient is possible through a unidirectional window.

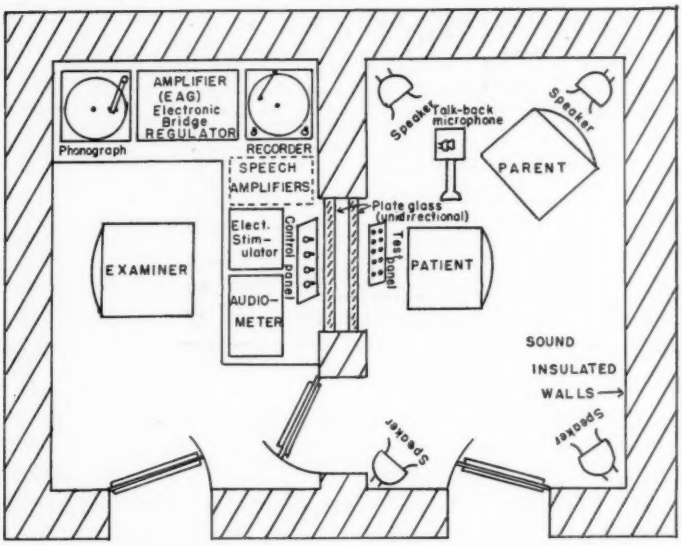


Fig. 8.—Audio testing rooms.

Close observation of the patient during the test is necessary in order to recognize and eliminate aberrant or inaccurate recordings. These might be due to excessive movements resulting in marked pressure changes on the electrodes or excitation by the patient, etc. The stimulating and recording apparatus are so arranged that the operator can simultaneously observe the instrument and patient being tested. The resistance of the patient is determined by balancing the wheatstone bridge and zeroing the pen at the desired level on the graph.

After the stimulating and pick-up electrodes are applied, the test head phones are put on. Whenever possible a complete headset is used, otherwise a single phone is applied by the nurse or parent to the ear under test. The conditioning procedure is similar to that used by Bordley and Hardy except that a condenser current is used. Frequently a conditioning shock stimulus is unnecessary and this position of the procedure can be eliminated.

The sound stimulus used as a conditioning stimulus consists of a 1000 cycle tone of high intensity varying from 60 to 100 decibels. An interrupter switch deflects the pen to indicate the onset of the

Fig. 9.

stimulus. Accurate measurements of the time elapsing between the sound stimulus and the response can thus be made.

The sound stimulus is usually followed within one to five seconds by the shock stimulus. The shock stimulus is of very short duration since a condenser discharge is very rapid. When a definite response to the sound stimulus is obtained after several stimuli, the threshold for the conditioning frequency is then obtained. This 1000 cycle tone is then followed by the 2000, 4000 and then the 500 cycle tones. These frequencies have been selected after considerable testing throughout the entire spectrum had been attempted in earlier tests. Fatigue often sets in when testing the younger children so that a complete test for both ears can not always be obtained. By limiting the test frequencies to the above mentioned four (500 c, 1000 c, 2000 c, and 4000 c), a practical distribution within the speech range can be obtained without unduly fatiguing the patient.

These tests provide valuable information to the otologist. It is advisable however to consider the possible use of complex sounds such as the complex clicks described by Rosenblith[27] in ordinary threshold audiometry. The advantage of clicks would be that of coverage of a wider discrete segment of the auditory spectrum and would actually be more informative than pure tones at octave or midoctave intervals.

The EAG—Physiological Analysis. A normal response shows a sharp rise forming a spike (Fig. 9, No. 1) and this is usually followed by a second rise higher than the first rise so that a double peaking

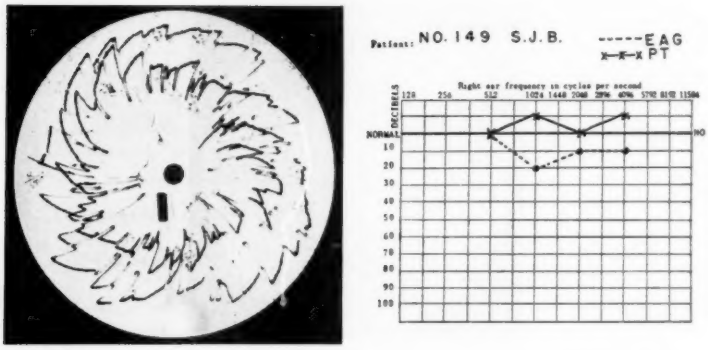


Fig. 10, Case 1.—Comparison of skin resistance electroaudiogram (EAG) and subjective pure tone audiogram (PT) (normal adult).

effect is obtained (Fig. 9, No. 2). Occasionally the spiking or peaking is reversed indicating a reversal in polarity.

The deflection of the pen is so arranged that a normal response moves the pen in a positive direction toward the center of the record (Fig. 9). This is done to minimize the effects of inertia upon the writing arm and pen of the recorder. A positive deflection of the pen resulting from a response is assumed to be due to the secretion of a minute amount of sweat beneath the pick-up electrodes and the resultant change in skin resistance. A lowering of the skin resistance occurs.

A moderately stable base line is found in the normal child and adult. Upon tone stimulation after conditioning a latent period of approximately two seconds occurs and this is followed by a sharp drop in skin resistance as indicated by the pen deflection. The pen then returns rapidly to the base line and remains inactive until the following tone stimulus. Some correlation seems to exist between the degree of deflection of the pen and the intensity of the tone stimulus. This ratio of pen deflection to tone stimulus intensity usually makes it possible to approach the threshold repidly in the normal (Fig. 10). A similar ratio is not always present in the individual with hearing loss.

Incomplete and variable records due to fatigue, emotional disturbances or lack of maturation were obtained in some infants less than twenty months of age, whereas some reasonably valid record-

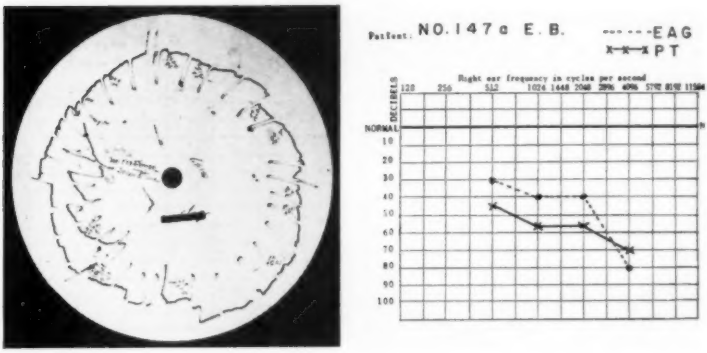


Fig. 11, Case 2.

ings were obtained from others in the same age group. It is hoped that further observations carried on in normal infants and in animals may shed some light on this phase of the testing.

Difficulty in obtaining adequate electro-audiograms was also encountered in brain-damaged children. Electrical stimulation does not always elicit a response despite the considerably greater intensity of stimulation employed. The latent period is variable as is the degree of response. The diffuse nature of the response in these individuals can not always be relied upon and often a conditioned reflex can not be obtained. In some instances when the conditioned reflex is established it is of a transitory nature so that constant reinforcement is required. When such difficulties are encountered in establishing a conditioned reflex to electrical stimulation, the electroaudiogram test is tried using sound stimulus only. A sound of high intensity of 1000 cycle frequency is used to set up the conditioned reflex. Occasionally this is successful. In some instances neither sound nor shock is effective and no record can be obtained.

The responses in the brain-damaged group exhibit several characteristic curves that are readily identifiable. The peaks are sharper, of shorter duration and usually in the form of a crescendo type of response. Continuous short bursts of activity during the ascending and descending portions of the response and a volley effect are present. This phase is of fairly short duration and then passes into either a hyperactive stage or a refractory stage.

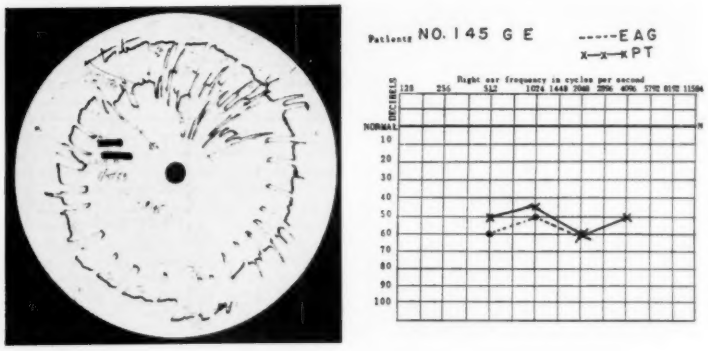


Fig. 12, Case 3.

Refractory periods are present during which no stimulus regardless of intensity produces a response. Following these refractory periods hyperactive periods occur in which random volleys of high intensity and frequency are observed. This hyperactivity then decreases in intensity and recordings can be obtained again. A refractory stage occasionally follows a hyperactive stage.

The base line in the normal is maintained at a moderately stable level whereas the base line in the patient with neurological disease shows a constant drift and produces a spiked appearance. The base line in these patients must be returned at frequent intervals. The drift in base line in these individuals is in the direction of an increase in skin resistance. Latent periods ranging from several seconds to almost forty-five seconds were noted in several. The character of these responses is also different, i.e., a slow steady drop occurs rather than the rapid, sharp drop seen in the normal individual. Various other changes are seen such as reversal of polarity. Abnormally large drops as well as increases in skin resistance occur in some.

A number of other interesting variations are observed that are indicative of and usually associated with several of the groups studied. The following case reports are illustrative of representative hearing losses.

TYPICAL EAG—SUBJECTIVE CORRELATIONS

CASE 1.—Otologic Diagnosis—Normal hearing threshold—in adult. Test—Normal spiking and double peaking typical of normal hearing level obtained. Rapid rise and fall of pen indicated normal physiological response (Fig. 10).

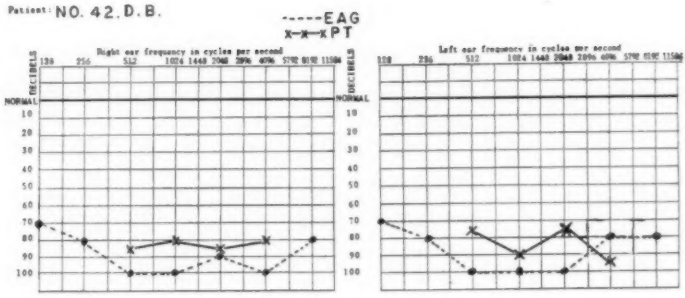


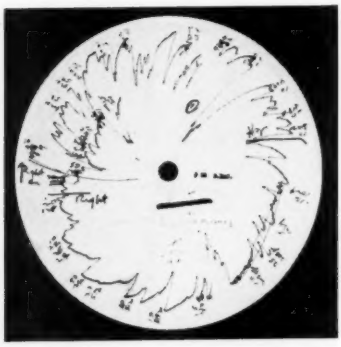
Fig. 13, Case 4.

CASE 2.—Otologic Diagnosis—Conductive hearing loss in an adult. Test—Typical response pattern observed. A low degree of autonomic activity present. Reinforcement of conditioning stimuli necessary. 15 db difference between the EAG and the pure-tone subjective audiogram was observed (Fig. 11).

CASE 3.—Otologic Diagnosis—Perceptive deafness in a 3 year old child. Test—Response to conditioning and sound stimuli good. Occasional marked changes in polarity. Autonomic activity increased as test progressed. Close correlation between EAG and pure-tone audiogram (Fig. 12).

CASE 4.—Otologic Diagnosis—Athetoid spasticity, bilateral neural deafness, due to kernicterus. Test—Adequate conditioned reflex to electrical stimulation difficult to obtain. Very low degree of autonomic activity, of short duration, sharp peaking and little evidence of a volley effect. Close correlation with pure-tone audiogram noted (Fig. 13).

CASE 5.—Diagnosis—Psychogenic hearing mutism. Test—Normal responses in time and amplitude. Fluctuating type of autonomic responses superimposed on major responses were present. Many reversed double notch type of responses appeared on the record (Note 1). Responses were considerably exaggerated for



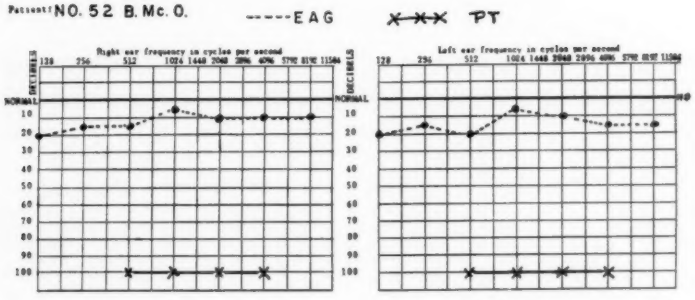


Fig. 14, Case 5.

some frequencies and intensities. Subjective pure-tone audiogram could not be obtained. Child failed to respond subjectively (Fig. 14). Following psychotherapy, normal hearing and excellent speech were demonstrated.

COMMENT

It is of the utmost importance to decide whether or not the electroaudiogram measures threshold responses. It is for this particular need that objectivity has been lacking. It is wise to speculate at this time on the possible neural arc involved in the transmission of an auditory stimulus via the cortex and through the autonomic nervous system to the sweat glands. Is this pathway necessarily capable of and constantly indicative of threshold? Is it not true that the determination of a threshold requires fine cortical cooperation? It is difficult to state that the responses elicited at so-called threshold in the EAG technique are equivalent to the threshold as determined by ordinary subjective techniques.

The EAG technique offers a very important basic tool in the study of the higher centers and pathways of audition. Practically speaking, the EAG is an important adjunct in the testing of hearing of young children. It is by no means the final answer to the problem of obtaining valid responses from an infant.

It has been our observation that in many infants the autonomic nervous system is not fully developed and that it is difficult to obtain sufficient changes to record even the electrical responses to shock alone.

There is no question but that this technic will offer valuable confirmatory evidence in malingering problems, dysacuses, aphasias and other central varieties of acuity impairment.

SUMMARY

The development of psychogalvanic skin resistance audiometric testing by Bordley and Hardy is a significant achievement in otology.

The interpretations of EAG findings are valid only when compared and evaluated with other types of auditory testing such as the startle reflex and the pure-tone audiogram.

We have been searching for a completely objective audiometric technique. While this is a non-subjective test, our search for a truly objective approach must continue.

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III

BILOBED PULSION DIVERTICULUM OF THE HYPOPHARYNX

A HISTORICAL SUMMARY AND A CASE REPORT

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There are few subjects in medicine about which there has been as much confusion, perpetuated inaccuracy and misinformation as there has been in the case of pulsion diverticulum of the hypopharynx. Even in the basic areas of anatomical and pathological description errors abound in spite of accurate initial descriptions. Today there are certain details to be learned with regard to etiology, however the symptomatology leading to accurate diagnosis is more widely understood and the surgical treatment of this condition is on a firm basis.

Since the first description of pulsion diverticulum of the pharynx by Ludlow[1] of Bristol in 1764 in a letter to William Hunter, this disorder has been the subject of considerable interest. His informative account entitled "A Case of Obstructed Deglutition, from a Preternatural Dilatation of, and Bag formed in the Pharynx" was first published in 1767. Ludlow's patient who had had typical symptoms of diverticulum for five years was treated as a last resort by swallowing a therapeutic tumbler full of one-half pound of quick silver on the assumption that the obstruction was due to *"schirrous or stricture."* Concerning the fate of the quicksilver he observed "but it passed not into the stomach, though it remained in our patient 'til he died, which was on the thirteenth day from our first attendance." At autopsy Ludlow found the first recorded instance of pulsion diverticulum of the hypopharynx and his accurate drawings are reproduced in the first illustrations (Figure 1). He further stated "and on the closest examination it was clear that this bag was formed by a dilatation of the entire substance of the posterior part of the *pharynx*." Further descriptions were made in 1811 by Monro[2] and in 1816 by Bell,[3] who suggested external fistulization as a form of treatment and stated "The bag was not covered with muscular fibers,

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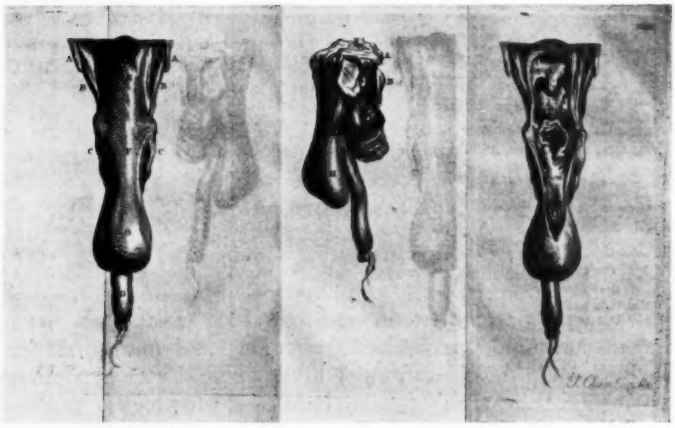

Fig. 1.—A photograph of the drawings by A. Ludlow to illustrate the first recorded case of pulsion diverticulum of the hypopharynx, drawn in 1764.

but may be described as a hernia or protrusion of the inner coat of the pharynx, betwixt the strong fibers of the muscular coat."

The fact that the origin of pulsion diverticulum in this region is actually in the pharynx has, therefore, been recognized since the earliest history of the disorder, and designations of the lesion being esophageal are anatomically erroneous. With symptoms referable to disturbances in the act of swallowing these lesions have naturally come to be referred to incorrectly as esophageal and more recently pharyngoesophageal.

In 1840 Rokitansky[4] described true esophageal diverticulum due to traction from esophageal adhesions to inflammatory parabronchial or paraesophageal lymph nodes and made a distinction between these lesions and pulsion lesions of the pharynx. Zenker[5] in 1877 and in the English Edition of von Ziemssen's Cyclopedia in 1878 further described pulsion diverticulum of the pharynx and traction diverticulum of the esophagus and emphasized the pharyngeal origin of the former due to pressure from within. Based on information gathered from the twenty-seven cases on which autopsies were performed since Ludlow's case and seven other cases Zenker emphasized that in a given case there was never more than one diverticulum, that the lesions were really herniations inasmuch as on careful examination

there was an absence of muscular fibers in the wall, and stated "The radical cure of diverticula by operative procedure from without is at the present time one of our vain wishes; yet we should hope that even this operation, conducted on Lister's plan, might at some future day be performed without danger."

Early attempts at the treatment of pharyngeal pouches were carried out by bouginage and the application of caustics to the sac, which was proposed by Dendy in 1848, as quoted by Zenker. There are numerous references to the advocation and attempted extirpation of pulsion diverticula followed by death in the pre-antiseptic era of surgery. One of the first surgical operations was diverticulotomy with external fistulization performed by Nicoladoni[6] in 1876, and this not for true pulsion diverticulum, but for a pouch secondary to lye stricture in a four year old girl.

According to Zesas[7] both Niehans and von Burkhardt performed diverticulectomy without survival of the patients in 1884 and Niehans again in 1888. The first successful diverticulectomy was accomplished by Wheeler[8] of Dublin in 1885 in a case where a pulsion diverticulum of the lower pharynx was found and removed incidentally during the course of an operation for congenital postfaucial diverticulum. Von Bergman[9] in 1890 successfully performed a planned diverticulectomy and Zesas[7] reported that Kocher, Butlin and Billroth repeated similar operations by 1892. In America Mixter[10] was the first to perform diverticulectomy with immediate suture of the wound in 1894, followed by Hearn[11] in 1896.

With the advent of antiseptic surgery cases were operated on by diverticulectomy followed by postoperative flushing of the wound with various antiseptic solutions. Liberal use of iodoform powder and open packing of the wound was also widely employed. Postoperative deaths largely from inflammatory complications were frequent and Zesas[7] reviewing the subject in 1906 reported that of the first forty-two cases operated on eight died. The introduction of aseptic surgical technique was accompanied by a reduction in complications, however, in 1910 Stetten[12] reported the mortality rate to be "only 16.6 per cent." In the same year, 1910, C. H. Mayo[13] reported six cases which had been treated surgically; four cases treated by amputation and immediate suture healed without fistula, and two other successful cases which developed fistula and required secondary closures.

As a result of the high mortality and morbidity rate from amputation and primary suture more conservative operations were developed. Girard[14] in 1896 described invagination of the sac and

Goldmann[15] reported a two-stage operation in 1909. In America conservative surgical management was further developed. Halstead[16] performed invagination of the sac in 1903 and was probably one of the first to advocate the use of bismuth paste as an aid to radiographic diagnosis of these lesions. Other methods of inversion were reported by Judd[7] in 1918 and Bevan[18] in 1921.

Several endoscopic operations were described by Mosher[19] in 1917 and Imperatori[20] in 1927. McClure[21] reported invagination of the sac with a subsequent removal by snare in 1934. C. H. Mayo[22] in 1923 emphasized the safety of the two-stage operation especially if the sac was large and Judd and Phillips[23] suggested it as the safest method for the aged. Lahey[24] reported on the two-stage operation in 1930 and there are numerous other reports advocating this method because of safety (Murphy,[25] Judd and Mayo,[26] McEvers,[27] and Sturgeon[28]).

In England, Hill[29] advocated simple diverticulopexy in 1917 and Moynihan[30, 31] advised the one-stage operation in his article in 1927 and further emphasized the pharyngeal origin of these lesions in 1932.

Gaub and Jackson[32] in 1915 reported the one-stage operation with esophagoscopic assistance and further reports were made on this method by Jackson and Shallow[33] in 1926 and Shallow and Clerf[34] in 1948. The obvious preferability of the one-stage procedure has been realized by many but not practiced widely prior to the days of antibiotic and antimicrobial therapy. Today with aseptic surgery and antibiotic therapy the one-stage procedure has been adopted by most of the former advocates of the two-stage operation and it is the method of choice of most surgeons (Harrington,[35] Shepherd,[36] Sweet,[37] Furstenberg[38] and Schall[39]).

Zenker's contention as to the rarity of multiple and abnormally shaped diverticula is confirmed by a review of the literature. Harrington[40] has reported a case of multiple bilateral lesions and Shallow and Clerf reviewing one hundred and eighty six cases in 1948 found "in two instances the fundus of the sac was bilocular." Pulsion diverticula of the hypopharynx may therefore vary with regard to size, shape, position and number. The following is the report of a case with a variation in the shape of the diverticulum.

REPORT OF A CASE

L. W. H., a forty-two year old white male was first seen on August 23, 1949, and presented the typical complaints of pharyngeal diverticulum. For almost ten years he had had difficulty in swallowing characterized mainly by noisy swallowing. Occasionally food would stick in the throat and he would become short

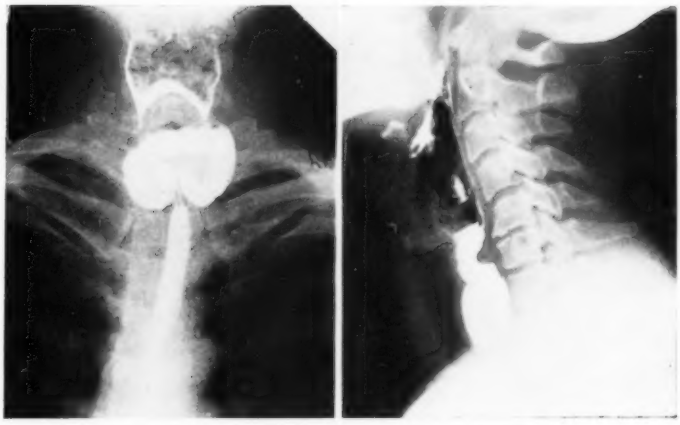

Fig. 2.—Pre-operative antero-posterior and lateral roentgenograms showing the bilobed hypopharyngeal diverticulum.

of breath. On such occasions regurgitation of undigested food would relieve the "tightness" in the throat. Coughing, particularly after eating and on retiring at night troubled him. He summed up all of his complaints by stating that he had a "stricture in the throat."

He had been well and strong all of his life and had had a tonsillectomy at thirty years of age.

On examination the vocal cords appeared and moved normally and the perilaryngeal structures were normal. Palpation of the neck after swallowing water elicited fremitus of fluid and air characteristic of pulsion diverticulum. When the patient compressed the neck while the larynx and hypopharynx were under indirect examination mucous could be seen to well up in the left pyriform sinus.

Radiological consultation by the late Dr. Rolla Karshner revealed a pharyngeal diverticulum at the usual site (Figure 2). Dr. Karshner further stated that "the diverticulum is unusual in that it consists of two sacs, one to the right and one to the left. The esophageal shadow descends down the midline between the two sacs. The sacs are in front of the esophagus. To me this is an unusual shape of pharyngeal diverticulum." He felt that there was a single opening but could not definitely state from the fluoroscopic standpoint the side of origin of the stoma. In view of this it was deemed advisable to examine the area thoroughly endoscopically. Pharyngoscopy was done under local anesthesia on August 29, 1949 and in the lower part of the pharynx a single moderate-sized stoma was found, more to the left than the right. Within a centimeter of the stoma two separate sacs were found, one to the right and one to the left, separated by a carina-like septum aligned on an antero-posterior axis. The left sac appeared somewhat larger than the right which extended to the right of the midline. The subdiverticular entrance to the esophagus could not be located with a boogie. The patient was discharged from the hospital and instructed to swallow a length of nylon thread. In several days time the thread was successfully swallowed, and on September 2,

Fig. 3.—Photograph of the gross pathological specimen.

1949 diverticulectomy was performed. A preoperative endoscopic examination was done and the string was found to enter the esophagus behind and to the right of the primary diverticular stoma. The right sac extended to the right of the string.

Using intravenous pentothal anesthesia with an intratracheal tube the steps of one stage diverticulectomy were carried out. A left lateral incision was made anterior to the sterno-mastoid muscle. The omohyoid muscle was divided and the superior thyroid artery was ligated and divided. The left thyroid lobe was then retracted medially and the left diverticular sac was found to be adherent to the posterior surface of the left thyroid lobe. The left sac was dissected free and the division between the two sacs located toward the neck of the diverticulum. The right diverticular lobe was then found extending anterior to the true esophagus and to the right and behind the trachea. It was dissected and brought into the left side of the neck. At this point neither the inferior thyroid artery nor the recurrent nerve were found to have an association with the indentation between the two sacs. Fibers of the crico-pharyngeous muscle were found below the lowermost edge of the neck of the sac. With the sacs held laterally an esophagoscope was passed with ease by Dr. Seymour Cohen and a feeding tube was inserted into the esophagus. The bilobed diverticulum was then amputated at its neck and the pharyngeal defect closed in two layers. A drain was placed in the inferior pole of the wound.

Convalescence was prompt. Swallowing was started on the fifth post-operative day and he was discharged from the hospital on the eighth post-operative day. The healing of the wound was primary and there was no fistula. Re-education in swallowing took some weeks, however preoperative symptoms were absent. Postoperative examination of the larynx showed that the vocal cords appeared and moved normally and the perilaryngeal structures were normal. Fluoroscopy and x-rays after swallowing barium on October 20, 1949 revealed normal deglutition and a slight

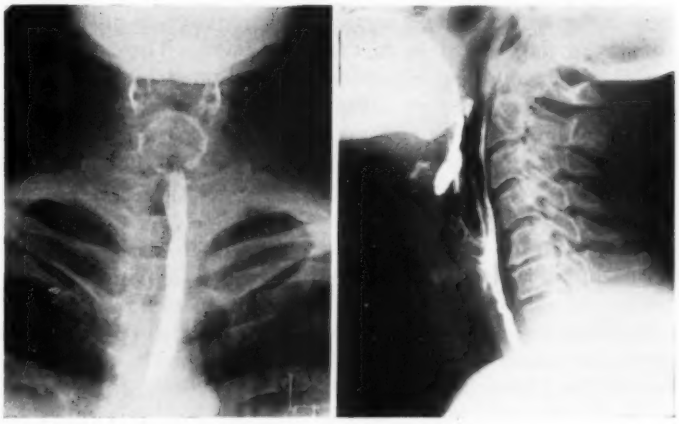

Fig. 4.—Post-operative antero-posterior and lateral roentgenograms.

nonobstructive irregularity of contour at the previous site of the pharyngeal stoma (Figure 4). He has been under observation for more than four years and has had no further dysphagia.

Pathology. The gross pathological specimen consisted of a bilobed sac (Figure 3). The left lobe was the larger of the two and communicated freely with the right by way of a narrow isthmus. Before fixation the mouth of the diverticulum was approximately two cm in diameter; the left diverticular subdivision was about four cm long and the right about three cm. Microscopic sections taken from the fundus of the sac and from the wall near the pharyngeal stoma showed stratified squamous epithelium, an absence of muscular fibers and a wall composed of heavy connective tissue with a loose adventitia. The sections taken near the stoma showed larger and more numerous blood vessels than at the fundus. There were a few scattered collections of chronic inflammatory cells beneath the epithelium.

COMMENT

Incidence. Macmillan[41] has reported the incidence of pulsion diverticulum of the hypopharynx to be three per cent of patients appearing for x-ray examination for disturbances in swallowing.

Etiology. Many theories have been postulated with regard to the etiology of these lesions, but most authorities agree that pulsion diverticula are acquired with the proper predisposing and exciting factors in operation. The important predisposing factor is the presence in the postero-lateral wall of the hypopharynx of a weak point between the lowermost fibers of the inferior constrictor muscle. Lahey[42] describes this point as the pharyngeal dimple.. Neuromuscular incoordination in the act of deglutition is generally recognized

as the important exciting factor. Jackson[43] long ago pointed out the importance of the crico-pharyngeal pinchcock mechanism and suggested that increased tone in the crico-pharyngeous muscle in the act of swallowing served as an exciting factor. There are various reports of "congenital" and "juvenile" forms appearing early in life, which certainly must be rare. Melamed and Walker[44] recorded a case of dissecting intramural diverticulum in a fifteen year old boy and Shallow[33] reported a case in a doctor who had had typical symptoms for forty years before coming to operation at the age of fifty-four. That the "inconstant hypopharyngeal diverticulum" of Holmgren may develop into a small constant diverticulum has been observed and reported in one instance by Bursell.[45]

Reports of variations in the size pulsion diverticula of the hypopharynx are numerous. Unusually large sacs which held 700 and 825 cc of fluid have been reported by Harrington.[46, 35] Lesions of this size are naturally associated with marked dysphagia and extend into the mediastinum to or below the aortic arch. Two cases in which the diverticulum extended to a point below the aortic arch have been reported by Spriggs.[47] Most surgeons advocate two stage operations for unusually large pouches and agree that the surgical hazard is usually greater partly because of the increased incidence of diverticulitis in these neglected cases. Large sacs are also likely to be found in the aged where treatment is not sought until a late date when the patient is debilitated. Small sacs may present difficulties in surgical exploration and location unless esophagoscopic assistance is utilized. They fortunately as a rule give meager symptoms and do not frequently come to extirpation. When discovered by accident while relatively asumptomatic they should probably be kept under observation until such time as distress in swallowing appears.

It is well known that most pulsion diverticula of the hypopharynx arise from the left or posterior aspect of the hypopharynx and are best exposed from the left side. There is some degree of confusion as to the exact position of origin of these herniations. Most authors agree that the commonest site is at a weak point in the postero-lateral wall of the hypopharynx between fibers of the "inferior constrictor and crico-pharyngeous muscles." Inasmuch as the crico-pharyngeous muscle is part of the inferior constrictor muscle (Spalteholz[48] and Morris[49]), the weak point and the site of the stoma may almost always be found between the crico-pharyngeous and thyro-pharyngeous fibers of that muscle or between diverging fibers of the crico-pharyngeous muscle alone. This fact certainly establishes the lesion as being a disorder of the pharynx.

Harrington's[40] case of multiple bilateral pulsion diverticula was treated by left-sided diverticulectomy. The right sac was small and not treated surgically. Together with some other unusual diverticula Jackson and Shallow[33] reported a case of "double diverticulum" in which esophagoscopy at operation disclosed two separate openings, one above the other, with no communication between the two sacs. The smaller left sac was removed and ten days later the right sac was extirpated. A recurrence of the right diverticulum required re-operation some months later. Shallow[50] suggested that "the deformity in the fundus of the sac as shown by the x-ray pictures is caused by the entrance of a branch of the inferior thyroid artery into the slit." He found it necessary to ligate a branch of the inferior thyroid artery in at least 35 per cent of his cases. The case of bilobed hypopharyngeal diverticulum herein reported has some features similar to the double diverticulum of Jackson and Shallow.[33] However as can be seen from the photograph of the pathological specimen there were two rather well defined pouches with a common opening into the hypopharynx.

Furthermore at operation neither nerve nor blood vessel could be found in the region of the bifurcation of the diverticulum to account for the variation in shape. There was neither hoarseness nor change in the motility of the vocal cords before or after diverticulectomy and it was not necessary to ligate the inferior thyroid artery or any branch thereof. The stoma communicated with the hypopharynx through its left postero-lateral wall between fibers of the crico-pharyngeous and thyro-pharngeous portions of the inferior constrictor muscle. The right sac was lodged between the trachea and the esophagus and extended into the right side of the neck and when filled compressed the trachea to about 60 per cent of its antero-posterior diameter as can be seen from the lateral x-ray of the neck. This then is an instance of an unusual shape of hypopharyngeal diverticulum which could give the roentgenological illusion of either multiple bilateral sacs or other lesions with separate hypopharyngeal openings. No reason could be found to account for the unusual shape.

CONCLUSIONS

A brief historical summary of hypopharyngeal diverticulum is presented together with some of the various evolutionary stages in the surgical treatment of this condition.

A case of pulsion diverticulum of the hypopharynx with an abnormal shape is presented, one in which a typical hypopharyngeal

diverticulum developed into a multilocular bilobed structure with a single opening into the hypopharynx.

The endoscopic findings are described and the importance of a preoperative endoscopic examination if there is anything unusual about the diverticulum is suggested. If the exact site of origin cannot be determined roentgenologically the value of endoscopic examination after the swallowing of a string is demonstrated.

One stage diverticulectomy with esophagoscopic assistance when necessary is advocated.

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IV

ORIGINS AND RELATIONS OF THE INTERNAL AUDITORY ARTERY AND THE SUBARCUATE ARTERY

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Perusal of the literature on the subject reveals a confused state of knowledge, and conflicting statements, with respect to the source of the internal auditory, or labyrinthine, artery. Most textbooks of anatomy state, as they have for many decades, that the internal auditory artery is a direct branch of the basilar artery, and show the vessel thus in their illustrations of the arteries of the region of the brain stem. Some anatomical accounts, at least as far back as Henle,[1] in 1876, include a statement that the artery may originate in common with the anterior inferior cerebellar artery.

The publications by Adachi[2] and his pupil Nabeya,[3] somewhat more than a quarter of a century ago, appear to be primarily responsible for the present state of confusion on the topic. These authors, and especially Nabeya, are often alleged to have found the internal auditory artery, in more than 200 specimens, constantly to be a branch of the anterior inferior cerebellar artery, never a direct branch of the basilar. Perusal of the publications by Adachi and Nabeya reveals, however, that they actually saw what Eichler[4] (1892) and others have reported but interpreted the observations differently. The following quotation translated from Adachi's paper clarifies the situation: "Even when it seems as if the internal auditory artery arises independently from the basilar, always there is jointly present a tiny artery which enters the cerebellum but which is very soon lost to view. This tiny cerebellar artery is in the overwhelming majority of instances the very delicate anterior inferior cerebellar artery lying dorsally to the nerve. Although the occurrence of an internal auditory artery arising independently from the basilar is indeed possible, I have never yet encountered one in the Japanese." Certainly it is not the custom of most observers to give the common

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stem of two arteries the name of the smaller branch, or to regard a tiny ("feinen") branch as the essential part of an artery.

Unfortunately, and apparently because of their mental bias on the topic, neither Adachi nor Nabeya state the incidence of the condition which Adachi admits often occurs, namely, the impression that the internal auditory artery seems to arise from the basilar. The fact that variations occur frequently in this region of the vascular system has long been known, and several authors have reported the incidence, in their materials, of the major patterns observed.

Cavatorti[5] examined 100 cadavers (Italians); both sexes were represented, the age range was 10 to 93 years. In somewhat over two-thirds of his specimens the internal auditory artery arose as a direct branch of the basilar (67 right; 70 left). It arose from the anterior inferior cerebellar artery 26 times on the right side but only 8 times on the left side. (Cavatorti used the old term "arteria cerebellaris media" for the anterior inferior cerebellar artery.) The vertebral artery was the source in 5 cases on the right side and in 21 on the left side. The source of the internal auditory artery was not identified in 3 instances; 2 right, 1 left.

Stopford,[6] in his studies on the arteries of the pons and medulla oblongata of 150 brains (English), found the internal auditory artery to arise most often (64 per cent right; 62 per cent left) from the anterior inferior cerebellar artery; in the other specimens, the source was the basilar artery; none came from the vertebral artery.

For the present study the difference in the incidences reported by Cavatorti and by Stopford is of less interest than is the fact that in their materials, as well as in that of the Japanese authors, variations in the origin of the internal auditory artery often occur.

The aspect of the variations of the internal auditory and the anterior inferior cerebellar arteries stressed in Cushing's[7] report is not differences in origin of the vessels but differences in their relations to the abducent nerve which might explain certain clinical observations. He found that either of these arteries, or their common stem of origin, may be ventral to the abducens, may be dorsal to it, or may pass between the roots of the nerve; and in some instances Cushing observed a sufficient indentation of the nerve by the artery to warrant use of the term "strangulation." For the present study the interest is not clinical but lies in the fact that variations often occur in an important anatomical relationship of the internal auditory artery as well as in its origin.

With respect to the origin of the subarcuate artery, perusal of the literature reveals ignorance rather than a state of confusion. Per-

haps many of the investigators of the blood vessels of this region of the body have observed the relation of the subarcuate artery to the internal auditory artery, but if so, most of them have, for one reason or another, neglected to record this aspect of their observations. The neglect, if such is the explanation for the almost total lack of mention of the subarcuate artery in textbooks, handbooks or other literature, may have resulted from an interest in variations of the larger vessels of the region or an interest in the distribution of the branches of the internal auditory artery to the membranous labyrinth. Whatever the cause of the neglect, or oversight or ignorance, certainly the fact that the internal auditory artery supplies important portions of the otic capsule and of the middle ear is not generally known by anatomists or by otologists.

The special literature on the blood supply of the temporal bone region contains, so far as my rather exhaustive search of it has revealed, only one description of the origin of the subarcuate artery, that by Siebenmann[8] in 1894. This author, in his monographic account of the blood vessels of the human membranous labyrinth, makes a brief statement in the text, and shows in a drawing, that in a specimen from a newborn the subarcuate artery is a branch of the internal auditory artery. The earliest account in which mention is made of an artery in the subarcuate region is that by Arnold[9] in 1845; this author states that in the diploic channel (subarcuate canal) described by Krause[10] (1843) an artery and a vein are present; no mention is made of the source of the artery. In 1869 Von Tröltsch[11] reported the developmental changes in the subarcuate region, from the five-month foetus to the adult; he found an artery definitely present in some of the adult specimens, but does not state its origin. Von Tröltsch's study of the region was extended by his pupil Wagenhäuser[12] (1882), who included numerous observations of animal forms. This writer stressed the importance of the subarcuate vessels in the nutrition of the bone of the mastoid and of the semicircular canal regions, in the adult as well as in the foetus and infant. By this time the subarcuate canal was well recognized as a potential route for the extension of infections from the mastoid region to the meninges and to the superior petrosal sinus (see, for instance, Odenius,[13] in 1864, Voltolini,[14, 15] in 1864 and 1868, Von Tröltsch,[11] in 1869), but was usually regarded as containing only a vein. Certainly it was so regarded by Siebenmann[16] himself, at the time he published his monograph on corrosion-anatomy of the temporal bone, only four years before the one in which the origin of the subarcuate artery was reported. In the earlier monograph (1890), the observations on 40 corrosion preparations, from all age groups, are reported. Sieben-

mann's findings with respect to the subarcuate canal are of special interest because his metallic casts of the connecting osseous channels agree nicely with the courses of branches of the subarcuate artery that have been determined by tracing in histologic sections.

To determine the origin of the subarcuate artery and the relations of it and of its parent vessels, as well as their origins, it has been necessary to utilize for the most part the methods of gross dissection. The vascular patterns of the vessels arising from the vertebral and basilar arteries and their relations to the temporal bone have been carefully examined at the autopsy table in six adults (12 patterns). The arrangements and interconnections of the arteries in the region of the subarcuate fossa and the entrance to the internal auditory meatus were thoroughly studied on 28 temporal bones, in addition to the 12 patterns. These 28 temporal bones were selected for examination, from a large number of gross specimens, removed at autopsy, because their vascular patterns were intact. All specimens were from adults. The magnifications afforded by Gullstrand spectacles and by dissecting microscopes have been used in tracing the smaller vessels.

The course and relations of the subarcuate artery and its branches within the substance of the temporal bone have been determined by the method of following individual blood vessels through serial sections of temporal bones, using the magnifications, as required for accurate identification, that are afforded by the various dry objectives (16 mm, 8 mm, and 4 mm) of a compound microscope. This part of the study, based on the examinations of 110 series of ear sections, is reported in a separate communication that deals with the blood supply of the entire middle ear (Nager, G. T. and Nager, M.[17]). The gross observations with respect to the topical anatomical relationships of the internal auditory artery and its branches within the internal auditory meatus have been supplemented by those made in following single vessels through histologic sections. No attempt has been made to follow in detail the arteries that supply the inner ear once they have entered the bony cochlea and labyrinth, or to describe them.

The 12 vascular patterns examined at the autopsy table, and afterwards, afforded examples of the principal variations of the vessels arising from the vertebral and basilar arteries that have been reported (by Cavatorti, Stopford, Adachi, Nabeya, and Cushing, above mentioned). The internal auditory artery was found to arise as a separate branch from the basilar, or as a branch from the anterior inferior cerebellar artery, or as a common stem, with the former

or with the subarcuate., from the basilar artery. It was not observed, in the 12 examples, to originate from the vertebral artery. In those instances where the internal auditory artery branches off directly from the basilar artery, it accompanies the seventh and eighth nerves into the internal auditory meatus, where it divides into its labyrinthine branches. Its relationship to these nerves on the way to the temporal bone is usually such that it courses between them. In the remaining instances its parent artery or the common stem from which it arises follows these two nerves. Whatever may be the vessel that accompanies these two cranial nerves, it may pass ventral or dorsal to the abducent nerve, and it usually supplies tiny branches to the intracranial portions of the fifth, sixth, seventh, eighth, ninth, and tenth cranial nerves, to the leptomeninges over the anterior aspect of the cerebellum and frequently to the dura mater at the posterior aspect of the petrosa, somewhat inferior and posterior to the porus acusticus internus.

Before the internal auditory artery divides into its labyrinthine branches, it usually gives rise to a major branch, the subarcuate artery; the variations in origin and relations of that artery will be described later in this paper.

The internal auditory artery enters the internal auditory canal in the space between the cochlear nerve and the two divisions of the vestibular nerve. Before giving origin to its well known terminal branches, the vestibular, cochlear and vestibulo-cochlear arteries, the artery supplies one or more small vessels to the dura and bone of the internal auditory canal. The vestibular artery passes along the under surface of the superior division of the vestibular nerve, often supplies a branch to the facial nerve and then courses through the macula cribrosa superior. The cochlear branch of the internal auditory artery enters the stem of the cochlear nerve, follows the twisting of the nerve trunk and, in the deep end of the canal, divides into a number of small arteries which pass through separate foramina of the area cribrosa spiralis. The vestibulo-cochlear artery may originate either as a branch of the cochlear or as a separate branch of the internal auditory artery. It courses along the under surface of the inferior division of the vestibular nerve and supplies two branches which accompany, respectively, the nerves to the posterior ampulla and to the saccular macula, then enters the basal end of the area cribrosa spiralis. The vestibular branches of the vestibulo-cochlear artery show, as to their origin, great variation, in so far as one or both may arise independently from the internal auditory artery. These observations were already made by Schwalbe,[18] Siebenmann[8] and Poirier.[19]

Each of the labyrinthine arteries, while following its respective nerve within the internal auditory canal, gives rise to a number of small branches; some of them join the dense vascular network in the surrounding nerve sheaths, and others penetrate the nerve trunk and ramify between the nerve fibres. Thus, the branch from the vestibular artery to the facial nerve anastomoses with a branch of the superficial petrosal artery, which enters that cranial nerve at the geniculate ganglion and then travels centralward to the fundus of the internal auditory canal.

The examinations at the autopsy table, supplemented by those on the 28 temporal bones, revealed also that whatever the variation in origin and course of the internal auditory artery, the subarcuate artery (or arteries) always arises either directly from it, or from its parent vessel, or from its branches. Usually the main stem of the subarcuate artery arises from the internal auditory artery outside the internal auditory canal, courses laterally and superiorly, and enters the temporal bone at the subarcuate fossa. This fossa is often merely a small depression in the fully developed temporal bone; it is situated somewhat above and behind the porus acusticus internus. In a small number of cases the branching occurs after the parent artery is in the internal auditory canal. The subarcuate branch then either passes out through the porus to reach the subarcuate fossa, or passes directly through the posterior meatal wall to the subarcuate canal. In the cases of double or multiple origin, the main stem of the subarcuate artery may enter at the fossa, and one of its tributaries may penetrate the posterior meatal wall. The reverse not rarely does occur, that a minor tributary from the internal auditory artery enters the usual way and is joined in the bone by the main stem which originates from the same parent vessel within the meatus and enters directly through the canal wall. When the subarcuate artery arises from a branch or from the parent vessel of the internal auditory artery, its stem, or one of its tributaries (in cases of double or multiple origin) usually enters at the subarcuate fossa.

In a few instances two or three arteries of similar caliber were observed to enter at the subarcuate fossa; in each instance one of the vessels arose from the internal auditory artery before it entered the porus, and the other, or others, came from the same parent vessel or from the anterior inferior cerebellar artery.

EMBRYOLOGIC EXPLANATION OF VARIATIONS

The observed variations in origin and relations of the internal auditory and the subarcuate arteries are not surprising if one remembers what is known about the embryologic development of blood

vessels in general and of those of the base of the brain in particular. The blood vessels of a region first appear as a capillary network, rather than in the final trunk like form, even in those places where the position of a vessel might seem to be predetermined by inheritance. Fortuitous circumstances, such as the relations to the adjacent larger vessels and the local requirements of the tissues for blood, determine which channels of the primitive capillary network differentiate into stem arteries and veins and which become branches and tributaries, also which channels atrophy and disappear entirely. This principle was first propounded by Thoma,[20] in 1894, on the basis of observations of the vessels of the yolk sac, and is frequently known by his name. The studies of Mall,[21, 22, 23] Zuckerkandl,[24] Flint[25, 26] and others on the development of the vessels of other regions have fully confirmed the correctness of Thoma's principle.

When applied to the vessels of the region of particular interest in the present study, Thoma's principle offers a good explanation of all the observed variations. The primitive capillary network is associated with the developing neural tube, otic vesicle and surrounding mesoderm. The developing nerve roots, especially those of the abducens, grow out through spaces in the capillary network. At an early stage medial and lateral longitudinal channels differentiate through the network, and a portion of the medial channels of the two sides fuse to form the single channel that will later be the basilar artery (Tandler,[27] Mall,[22] Streeter,[28] Congdon[29] and Padget[30]). The caudally unfused portions will become the vertebral arteries. The capillary network at this stage is connected at numerous places with both the fused and the unfused portions of what will soon be the main source of blood for the tissues and organs that are developing in the region supplied by it. The hypothetical possibilities for variation of the connections of the final arteries to the adult tissues and organs of the region are even more numerous than are the observed variations.

Unknown circumstances determine whether the derivatives of the otic vesicle, for instance, are finally supplied by growth of a channel cephalad to the roots of the abducent nerve, by growth of a combination of channels in the network caudad to the roots of the abducens, or by growth of a series of channels connected to the vertebral artery. Likewise, unknown circumstances during development of the region determine whether the derivatives of the otic vesicle, for instance, are supplied by a vessel that also supplies derivatives of one or more of the other embryonic tissues of the region. The relations of the primitive network adequately explain why, in the course of its differentiation by growth of some channels and

atrophy of others, the arteries to some regions often have a segment in common, also why the derivatives of the mesoderm near the otic vesicle (mainly bone of the otic capsule and dura mater) may receive blood both from the labyrinthine artery and from the anterior inferior cerebellar artery.

The presence, in an adult, of a common stem of origin of the labyrinthine and the anterior inferior cerebellar arteries simply means, according to this explanation of the variation, that during the embryonic life of that individual only one, rather than two, of the medial channels of the capillary network to the tissues supplied by the lateral (or the peripheral) part of the network enlarged and persisted. The place at which the common stem (or the two arteries, when they arise separately) is connected to the basilar or to the vertebral artery indicates, in a general way, the location of the primitive channel that grew and persisted. If, for instance, the artery lies between the brain stem and the abducent nerve (as Cushing found it in many instances) one of the more cephalad of the medial channels in the primitive network must have grown to become the definitive vessel later.

Each of the observed variations in origin of the subarcuate artery, above recorded, can also be explained as a result of embryologic variations in how many and which of the lateral channels in the primitive capillary network of the region grew and persisted. A double or a multiple origin of this artery to the otic capsule means simply the growth and persistence of more than one of the lateral channels in the network associated with the differentiation of the mesoderm of the region. If the favored channel to the mesoderm chances to be in the part of the network that also supplies the developing membranous labyrinth, the result is an origin of the subarcuate artery from the labyrinthine artery or from one of its branches. If the favored channel, or one of the favored channels, chances to be from the part of the total network that also supplies the developing cerebellum, the result is an origin of the subarcuate artery, in whole or in part, from the cerebellar artery of the region, the anterior inferior one.

The variations in origins of the vestibulo-cochlear artery and of its branches, that have been previously reported and again observed during the present study, can also be explained as results of embryologic variations in the differentiation of channels through the primitive capillary network. Atrophy and disappearance of certain of the lateral channels that are associated with the developing membranous labyrinth can result in shifting the origin of the future

vessel, or of its branches, to one of the branches or even to the stem of the internal auditory artery.

With Thoma's principle and the embryology of the region in mind, the statements of Nabeya and Adachi with respect to the close association of the internal auditory artery and a vessel to the cerebellum cease to be confusing. Their observations, instead, provide numerous examples of a result to be expected in the differentiation of channels through the primitive capillary network of the region. It is not their observations, but only Adachi's interpretation, that has led to confusion and misunderstanding.

SUMMARY

The literature on the topic, which is reviewed, indicates confusion with respect to the significance of the reported variations in origin and relations of the internal auditory artery and almost total ignorance with respect to the origin of the subarcuate artery. Careful examination of the vascular patterns of the region, at the autopsy table and in a selected group of removed temporal bones, confirmed the wide range of variation in the internal auditory artery previous investigators have reported and also afforded evidence of a close relationship between it and the subarcuate artery. Whatever the origin and course of the internal auditory artery, the subarcuate artery (or arteries) always arises either directly from it, or from its parent vessel, or from its branches.

Thoma's principle of how definitive vascular channels develop from a regional primitive capillary network is applied to the region under consideration and is believed to offer an adequate embryologic explanation of all the observed variations in origin and relations of the internal auditory and the subarcuate arteries.

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V

THE DEVIATED NOSE

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This contribution will deal only with the crooked nose that is the result of trauma and healing in faulty position. Such a nose presents complicated architectural problems and raises the basic question as to what structures contribute to the deformity. Obviously defects may be confined to the external nasal skeleton only, the internal nasal skeleton only, or may lie within both. The deviated nose that has structural faults in only the external or internal skeleton is relatively rare when compared to those that have both internal and external deformities. However, while studying the twisted nose it is simpler to give attention to only external or internal imperfections before considering both concomitantly. We shall therefore discuss the pathologic anatomy and the correction of different types of deviated noses in the reverse order of their frequeqncy:

1) Defects limited to the external skeleton only.
2) Defects limited to the internal skeleton only.
3) Defects involving both the internal and external nasal skeletal apparatus.

The simplest nasal deviation is the one in which the external skeleton alone is involved and in which the whole nose is deviated to one side or the other in a regular manner (Fig. 1). Here the lower two-thirds of the nose appears to be carried laterally only because of its attachment to the deflected nasal bones. A nose of this type is usually satisfactorily corrected by midline section of the nasal bones and upper lateral cartilages, lateral osteotomies, and repositioning. Another variety is the regularly deviated external nose with a hump involving either the nasal bones, the upper lateral cartilages, or both (Figs. 3a and b). A displaced nose that presents a dorsal hump is less of a surgical problem than the same type of nose without a hump because unequal removal of the hump allows the two sides of the

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3A
3B

nasal pyramid to be made equal in length and affords the surgeon more space in which to maneuver.

When the nasal bones are deviated but the lower two-thirds of the nasal skeleton lies in or near the midline the correction involved is about the same as is indicated when the entire nose is deviated. The same holds true when the nasal bones and upper lateral cartilages are deviated while the tip lies in or near the midline (Fig. 2).

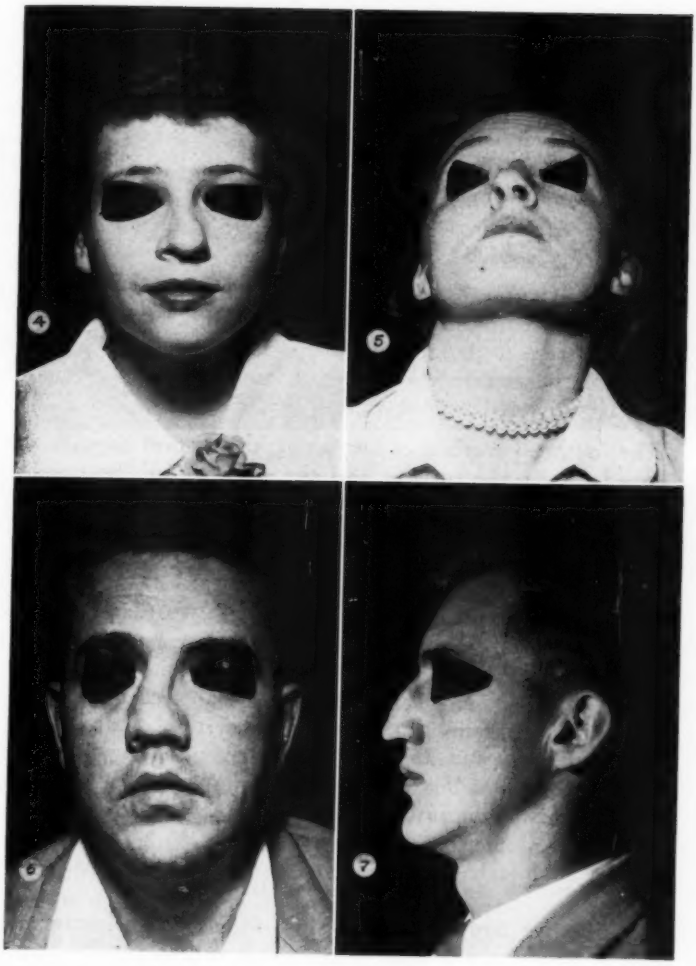
Post-traumatic nasal deviations involving only the tip (without septal deformity) are practically impossible unless there has been loss of soft tissue. In tip deflection the septum is nearly always deformed and septal correction will usually prove adequate in moving the tip toward the midline.

Those cases of nasal malalignment depending entirely upon faults within the internal nasal skeleton exhibit no deviation of the nasal bones but one or both segments of the cartilaginous vault will lie away from the midsagittal plane. The first example of this type presents involvement of only the upper lateral cartilages while the nasal bones and tip are in or near the midline (Fig. 4) The underlying faulty anatomy is a C-shaped deformity of the ventral portion of the septum. Correction of the septal curve will often be enough to straighten the nose, but additional unequal trimming of the mesial edges of the upper lateral cartilages may be necessary to obtain a satisfactory result.

The deviated nose that has its variance from the midline confined to the upper and lower lateral cartilages can at times be adequately treated by correction of the underlying septum. Extreme or long-standing deformities of this type may also require unequal trimming of the upper and lower lateral cartilages before the nose will assume a normal position.

Deviation of the nasal tip alone (Fig. 5) is nearly always the result of a dislocation of the caudal end of the septal cartilage and can usually be corrected by septal replacement although trimming of the lower lateral cartilages may be indicated.

As was stated previously the twisted nose will usually present abnormal anatomy in both the internal and external nasal skeletons. The problem in regard to the external nose remains the same but is complicated by the contribution of the septum. The basic questions to be answered in this situation are whether the septal deviation will prevent midline positioning of the external nose, whether the twisted external nose allows too little space for returning the septum to normal position, or whether both mechanical problems are in effect.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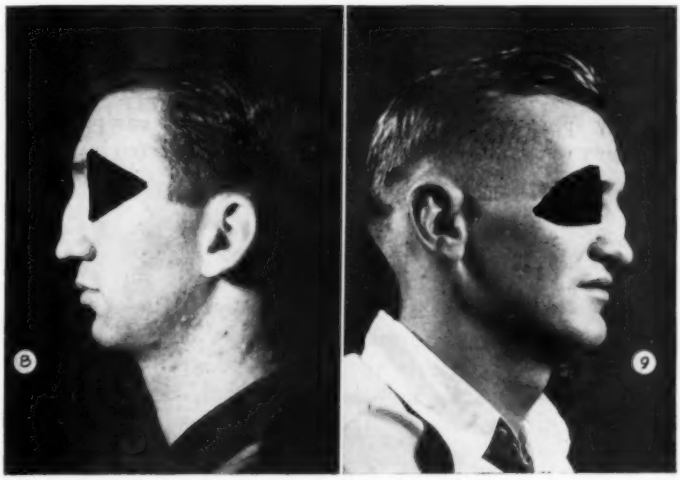
The next questions that logically arise are whether the septum should be corrected first, whether the external nose should be repositioned first, or whether both procedures should be done at the same time. Numerous occasions arise in which a nose can not be straightened without moving the septum at the same time and vice versa. Operation on both the internal and external nasal skeletons at one procedure has the advantage of saving the patient an extra operation and additional hospitalization. A disadvantage lies in the fact that so many supporting structures are healing at once that the end result in regard to both the external and internal skeletons is less predictable than when the internal and external support are attacked one at a time.

If internal and external reconstructions are to be done in two stages, the septum is corrected first when it appears that it would be an obstruction to midline positioning of the external nose. The external nose is corrected first when it is obvious that it would be in the way when shifting the septum to the midline.

The indicated method of correcting the septum depends upon the experience of the surgeon and the demands of the particular case. It may prove that a generous submucous resection will weaken the ventral portion of septal cartilage enough to keep it from holding the nose in an undesirable position but will not weaken it enough to allow collapse. When the septum shows a smooth and regular deflection its detachment from the upper lateral cartilages and submucous detachment from the floor of the nose may allow it to be swung to the midline in a trap-door fashion. Partial septal removal with cross-hatching, shaving, and fracture of the remaining portion may be indicated in other cases. In some cases it appears necessary to remove the entire septum and replace it in the midline as a free graft. We have no particular "favorite" way of dealing with the septum and will use any method or any combination of methods that seem most advantageous.

SPECIAL PROBLEMS

I. *Extreme Bony Deviation* (Fig. 6). In such instances the osteotomy defect on one side of the nose is so much wider than its opposite fellow that recurrence of the deviation during healing is threatened. This problem can be treated by using a bone graft to prop open one or both spaces remaining after osteotomy. Bone from a removed hump can be used or a segment or removed vomer can be inserted. Another excellent method involves resection of a wedge from the osteotomy on the long side and insertion of the wedge into the osteotomy cut on the short side. When an extremely wide



space is needed to allow correct positioning of the nose and a large wedge is desired for use as a prop we have several times resorted to resecting the wedge through a Caldwell-Luc incision.

II. *Multiple Deformities of the External Nose.* A real or apparent bony hump often accompanies a real or apparent cartilaginous depression and lateral deviation. The nose that presents a large bony hump with only an apparent depression of the cartilaginous portion of the dorsum (Fig. 7) can be handled by excision of the hump down to the level of the cartilaginous vault and correction of the deviation by lateral osteotomies. A bony hump accompanied by an unusually low cartilaginous vault (Fig. 8) can often be treated adequately by excision of the bony hump and shifting it downward to fill the defect over the cartilaginous vault.

An occasional case is encountered in which the internal nasal support has been so weakened by previous surgery, the bony deviation so great, and the cartilaginous depression so deep (Fig. 9) that almost total construction rather than reconstruction is needed. In such cases we have at times resorted to one-stage hump removal down to the level of the saddling, repositioning of the nose by means of osteotomies, and provision of external skeletal support by means of an iliac graft.

SUMMARY

Traumatic nasal deformities present mutiple variations and more interesting problems than do congenital or developmental ones. We believe that there is no single best way of dealing with any particular type of old nasal trauma. The surgeon must of necessity be acquainted with many approaches to any single problem and be equipped to use any or many means to provide the best result in any given instance.

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VI

ASPECTS OF HEARING PHYSIO-PATHOLOGY DURING THE FIRST POSTOPERATIVE PERIOD FOLLOWING FENESTRATION

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It has been our task to study the behavior of hearing after fenestration on the basis of current literature and of our own experience, as we think that findings immediately after fenestration will furnish interesting data on functional aspects of the ear, and explain some problems which have been considered in modern literature and not yet resolved.

Thirty cases of otosclerosis belonging to Shambaugh's "A" group, operated on by Lempert's "cupole" technique, have been studied. The following elements have been considered for the evaluation of the hearing behavior: a) modifications of hearing by bone conduction, b) modifications of hearing by air conduction, c) behavior of Weber's test, d) results of speech-audiometry tests, e) behavior of Fowler's test, f) study of diplacusis.

These tests have been performed three days, eight days and a month after fenestration of the lateral semicircular canal. The first test was performed after three days, as we know that during the first hours after the operation the patient remarks a noticeable improvement, though it varies very much, as it is due to unstable acoustic sensations which are anomalous and cannot be analyzed. Control of hearing behavior during that period appears therefore to be difficult and of no value. Furthermore the after-effects of drugs used for anesthesia contribute to the impairment of the tests.

After 48 hours this hearing improvement disappears and the hearing capacity of the patient, which has become normal again, allows us to study the hearing behavior of the cochlear apparatus.

Here are the results of the various tests:

Third Day After the Operation—All tests have been performed without removing the bandage.

From the Ear, Nose and Throat Clinic, University of Milan, Milan, Italy.

Air Conduction: The threshold for all frequencies is lowered with main impairment in the higher frequencies. Here are the mean values in decibels of the differences between the preoperative threshold and that of the third day after intervention:

Cps 128	+20.4	Cps 1024	+26.3
" 256	+15.8	" 2048	+40.5
" 512	+16.8	" 4096	+50.4

Weber's Test: 512 - 1024 - 2048 lateralized to the side of the operation 100 per cent; 4096 30 per cent as above, 70 per cent lateralized to the opposite side.

Bone Conduction: Owing to the bandage the investigation of bone conduction has been performed by putting the receiver on the zygomatic bone and by testing middle frequencies only. The results were nearly identical to those obtained by testing the ear which had not been operated on.

Fowler's Test: No recruitment could be found in any of our 25 cases.

Eighth Day After the Operation: The patient has had his first medication three hours before undergoing the audiometric examinations. Only two little pieces of gauze had been left in the operative cavity.

Air Conduction: In low and middle frequencies, air conduction is back to preoperative levels, in high frequencies the deficit is still high. Here are the mean values (in decibels) of the difference between the preoperative threshold and the one of the eighth day after intervention:

Cps 128	+5.6	Cps 1024	+5
" 256	0	" 2048	+28.3
" 512	0	" 4096	+40
		" 8192	+50

Bone Conduction: 40 per cent of cases maintained preoperative levels; 60 per cent maintained the preoperative levels up to 3000. At 4096 a loss of 15-20 db has been observed.

Weber's Test: 512-1024-2048 lateralized to the side of operation, 100 per cent of cases, 4096 40 per cent as above 60 per cent lateralized to the opposite side.

Fowler's Test: No recruitment could be found in any of our cases.

Speech audiometry: The articulation curve was the same as in the ear not operated on; the discrimination threshold was quickly reached.

Diplacusis: Could not be found in any of our cases.

From these researches we may draw the following conclusions:

Hearing acuity gets better during the first 48 hours after the operation but this gain is uncertain and of no practical value. On the third day an impairment appears, whose mean value is over 25 db for low and middle frequencies and over 40 db for high frequencies.

The impairment of high tones lasts more than a week and it can still be noticed in tests performed immediately after the first medication (eighth day); the threshold for low and middle frequencies instead, goes back to preoperative values.

Starting from the second week, hearing improves more or less quickly, and the preoperative threshold is reached and passed.

At the end of the first month bone conduction reaches a level which is supposed to be definitive and the mean improvement appears to be higher than 20 db. The highest gain is seen in middle frequencies as compared to high frequencies where the result is not so marked, as in "A" cases (first stage cases with rising audiometric curve).

Hearing improvement has always been reached rapidly in middle and high frequencies. This is certainly related to the improved surgical technique which allows a reduced trauma of the labyrinth.

Some interesting conclusions can be drawn from the behavior of hearing in high frequencies immediately after the fenestration. All the authors who studied this fact (Shambaugh, Lempert, Juers et al[12, 15, 23]) have stated that postoperative labyrinthine reaction responsible for the impairment of higher frequencies which is progressively reduced starting, usually from the fourth week, is due to aseptic serous labyrinthitis. On the contrary the hearing acuity in our 30 cases has improved rapidly and the impairment of high tones, which could no longer be seen a month after the operation, was probably not related to a labyrinthine alteration as it was accompanied by audiometric findings which were definitely not characteristic of a cochlear alteration.

Let us now consider these audiometric findings. As bone conduction is used to evaluate the preoperative cochlear function, we may as well assume that it will enlighten also, after operation, in

regard to any surgical injury to Corti's organ. Various authors have studied modifications in bone conduction, but they have usually investigated the late results without performing any test during the first weeks after operation, though we know that only these tests are able to point out the existence of a postoperative labyrinthitis. Shambaugh only has found after an immediate improvement an impairment of bone conduction especially for high frequencies. As this impairment can be seen for high frequencies of air conduction too, this author thought it to be due to postoperative labyrinthitis. He believed further that bone conduction would reach its immediately postoperative level only with the disappearance of the above mentioned labyrinthine reaction. Juers[12] thinks that there is no modification of bone conduction immediately after operation but only a late improvement of perception.

Some authors have tried to determine the behavior of Weber's test during the first postoperative period. This simple method is very useful if one wants to identify from the beginning an impairment of cochlear function. All the authors who studied bone conduction by means of this test have found that the Weber test is often lateralized to the side of the ear which has been operated on. (Juers 55 out of 88 cases). This sign indicates that the labyrinth has not suffered during the operation. As a matter of fact we know that even the slightest labyrinthine irritation, as represented by a simple injury to the labyrinthine lymphatic system (the so-called Mygind's "labyrinthosis" where we find only qualitative and quantitative modifications of the fluid), always impairs the bone conduction and thereby modifies Weber's test.

Juers has noticed that hearing improvement was less marked in patients who, immediately after the operation, showed a Weber lateralized to the side which had not been operated on. Furthermore he found out that there was an impairment in patients who had it first lateralized to the side of the open labyrinth and later to the opposite side.

As it has been shown too that packing of the operative cavity had no influence on the Weber lateralization, we must agree that one cannot assume the possibility of a labyrinthitis when the Weber is lateralized to the ear operated on.

In 100 per cent of our cases Weber's test was lateralized to the side operated on, and bone conduction showed practically no alteration—a sign that the cochlear apparatus had not suffered any damage. Bone conduction on the third day was investigated by putting the receiver on the zygomatic bone (because of the bandage on the

mastoid) and was shown to present threshold levels identical to those of the other ear. On the eighth day the levels of bone conduction were the same as before the operation.

In 60 per cent of our cases an impairment of 15-20 db if compared to the preoperative threshold was noted only for the 4096 frequency. The lateralization of Weber's test for this frequency to the side not operated on confirms this impairment which on the other side cannot be related to a labyrinthine reaction due to the operation, as this sort of reaction is supposed to create a state of hydrops and thus determine a rise uniform for all frequencies of air and bone threshold (as seen in Ménière's disease). Though we do not know up to now the origin of this particular localized cochlear affection. One may gather it to be due to the mechanical or acoustic trauma done by drilling the canal.

Many factors may lead to this sort of injury, as the proximity of the inner ear to the drilling, the presence of a good bone conduction, and the surgical removal of the structures of the middle ear responsible for the protection of Corti's organ from too intense stimuli. The damage is, incidentally, always a slight one. The impairment appears to be reversible and bone conduction (for the 4096 frequency) had in 70 per cent of cases reached its preoperative levels after one month.

Speech audiometry was another test we performed in order to evaluate the cochlear behavior.

In all of our 30 cases we obtained a rapidly increasing articulation curve, which was parallel to the one of the other ear and whose discrimination threshold was reached in a short time. This is considered as proof that the cochlea had suffered no damage, as we know that any alteration of the labyrinth would have as a consequence a deformed articulation curve, slowly rising, with a diminished threshold of intellection (100 per cent).

Control of recruitment whose diagnostic importance is already established, was done by Fowler's and Lucher's tests. No recruitment could be found in any of our patients, three and eight days after the intervention: that is to say that we could not notice any disproportion between the rise of intensity and the rise of sensation.

As an increase of the perilymph's density as well as a narrowing of the two cochlear stairs, as may be produced by a slight labyrinthitis, may bring to a displacement of the tonal height, we have tried to find out if there exists any sign of diplacusis in our fenestrated patients. No such sign was seen eight days after the operation. We

did not try to investigate it on the third day as it requires too much attention on the part of the patient. We think though, that, even if it should be found in some cases, one should not consider it as a sign of labyrinthitis as this phenomenon may be present even if only the middle ear is affected. As a matter of fact Steve and Davis point out that all lesions modifying the mechanical characteristics of the transmission apparatus, especially the rigidity and mass, may be held responsible for diplacusis as, by altering the frequency of resonance, they may alter the intensity of transmission of pure tones and modify tonal perception of a complex sound by acting on the intensity of some of its components. We may therefore conclude that all the results of these audiometric tests show that the anterior labyrinth has not suffered from the surgical trauma; the impairment of high frequencies that can be observed three and eight days after the intervention is therefore not due to a labyrinthitis.

But how is it possible to explain the steeply falling curve with a good bone conduction? It must be due to an alteration of the transmission apparatus. It is well known that a fall in high tones may be due to a middle ear lesion, and that the old conception: transmission lesion, deafness for low tones, and perceptive lesion, deafness for high tones has proved to be of no value. We may easily understand all this if we think of the physiopathology of sound transmission and of the importance of mass, rigidity and friction for hearing.

The vibrating complex of the middle ear behaves approximately like an elementary mechanical system, which is able to perform periodic movements.

The resistance of this system to the periodic displacement varies with the mass, the rigidity, the friction and the frequency of the force applied. If we apply to this system a periodic force of the same frequency as the one of the natural period of the system, oscillations will be maximal, and impedance minimal (frequency of resonance); instead, if the periodic force is below the natural period, oscillations will become smaller with the increasing of the mass.

We may apply the formula of impedance of a simple vibrating system to the middle ear, as the transmission apparatus is formed by a few simple systems like the one we described above. We gather from that formula that an increase of mass leads to an increase in impedance at high frequencies, while an increase in rigidity leads to an increase of resonance frequency, by augmenting the impedance for low frequencies.

The mass of the ear's vibrating system is formed by the malleus, the incus, the drum and the labyrinthine fluids. Rigidity is repre-

sented by the tension of the drum, by the elasticity of the round window, by the basilar membrane and by the degree of contraction of endaural muscles. All these elements may be modified by various pathological conditions and the effects of these modifications on sound transmission and, consequently, on hearing acuity, may be various.

In our case we know that otosclerosis gives rise to a typical alteration of rigidity: the audiometric curve is, at least at the beginning, a rising one as the increased stiffness of the ossicle chain increases the impedance for low frequencies by leading to an increase of the resonance frequency.

We have seen that these patients present during the first postoperative period a falling curve with impairment of high frequencies. As we know that this curve is not due to a cochlear impairment, we may think it to be due to an alteration of mechanical constants in the middle ear.

Are there any alterations of the transmission apparatus which justify these alterations of hearing by air conduction? Nilsson[18] gives us some interesting data on modifications which take place in the middle ear during fenestration. He has investigated the behavior of hearing after the first part of Lempert's operation and has found a noticeable fall at high frequencies. As these patients had been studied before operating on the labyrinth, the alteration at high frequencies must be due only to an impairment of sound transmission. Nilsson[19] thought it to be due to an increase of the mass due to the tympano-meatal flap, and the removal of the head of the malleus and of the incus.

Other modifications of mechanical constants of the middle ear arise during the first postoperative period. As we know, fenestration is a sort of orthopedic intervention intended to create a new system of transmission of sound vibrations to the labyrinthine fluids as a substitute to the normal anchylosed one. This surgical reconstruction simplifies and modifies remarkably the physical characteristics of the middle ear. The drum is conserved but pulled and displaced towards the tympanic cavity, as it has been partially detached from the annulus when the flap has been prepared. This fact, and the cutting of the head of the malleus, leads most probably to a modification of the axis on which the membrane vibrates.

There is furthermore a displacement of the membrana flaccida which is pulled towards the new window. Removal of the head of the malleus and of the incus deprives the ear of two important functions; adaptation of mechanical possibilities of the transmission system

to the receptive system and protection of the cochlea from too intense stimuli. Moreover, the laying of the flap on the fenestra, the removal of endaural muscles and ligaments not only modify the mass, the stiffness and friction of the transmission apparatus but also no longer allows a variation of these physical characteristics according to functional requirements thereby creating an obligatory system. There are, consequently, obvious functional differences between the normal transmission apparatus and that following fenestration. Therefore it appears logical that patients require a period of adaptation in order to get accustomed to the new situation and to new functional conditions which have been created by the opening of the new fenestra. Only after this period will the patient be able to reach the maximum of hearing acuity. Besides, it is well known that the drum, the mucous membrane of the middle ear cavity and the flap usually undergo an intense edematous reaction owing to surgical trauma and to inflammation.

It is possible that edema and serosanguineous or purulent exudate may be held responsible for the impairment of high frequencies as, by increasing the mass (a considerable increase owing to small values of mass under normal conditions) it impairs the frequency of resonance of the system, thereby increasing impedance for high frequencies. The round window cannot substitute for the impaired function of the new window as exudate which accumulates in the operative cavity increases tension of the oval window membrane.

Modifications arising in the middle ear after the operation and particularly the increased mass may thus justify and explain the impairment of high frequencies and the audiometric findings of our patients.

It appears from all we have said that the anterior labyrinth behaves differently than the posterior one. Only the posterior labyrinth suffers from operative trauma as proved by the vertigo, nystagmus and vomiting which appears in the first postoperative period.

It is remarkable that vestibular symptoms reach their peak a few hours after the intervention while the cochlear signs appear on the third day, the hearing acuity of the patient being good during the first 24 to 48 hours.

Two of our patients with a remarkable vestibular reaction, who had nystagmus and vertigo up to 20 days after the operation, showed no signs of cochlear alteration during the first two weeks.

Incidentally it is not a rare thing for a pathological process to be limited only to a single part of the labyrinth. The literature re-

cords many cases of isolated affections of the posterior labyrinth and of surgical damage done to it without any clinical or anatomical sign of damage to the cochlea. Surgical methods have been suggested which allow the functional removal of the vestibular receptors without a lesion of the cochlea by reaching the labyrinth through an opening in the lateral semicircular canal. Menzio[16] has described a method of hemilabyrinthectomy with conservation of the cochlear function and has shown the effects of fibrin sponge application on the labyrinthine cavity of 32 guinea-pigs. This author says that no modification of hearing acuity on the side operated on, compared to data obtained before operation, could be detected. A series of histological sections has shown further that there was no sign of reactive or infiltrative changes. The whole structure appeared to have normal morphological characters. Surgical injury in this operation is certainly greater than in fenestration, nevertheless no modification was present either on the scala vestibuli or on the scala tympani. Consequently there are not only audiometric but even clinical proofs that the anterior labyrinth may not suffer from surgical trauma. Histological findings too confirm these views, provided the lesions of the labyrinth have been made with the same technique used for human surgery. When no account was taken of this point, serofibrinous or purulent exudate with a tendency to organize and to deform the membranous labyrinth could be seen in the perilymphatic and endolymphatic spaces. In endolabyrinthine reaction after fenestration were of this type we could notice modifications of the hearing acuity far more pronounced than the limited impairment of high frequencies and these modifications would likely be irreversible. Histological specimens taken from animals operated on by modern methods of human microsurgery show (as stressed by De Amicis[8]) that after perforation of the labyrinth, endolabyrinthine reactions are proportional to the nature and the extension of the trauma: minimal and strictly limited to the injured spot if trauma is small, extended if trauma is severe.

We may conclude that, based on audiometrical findings and on clinical and histological data, symptoms to be seen after fenestration cannot be grouped in a single syndrome as an expression of the whole labyrinthine reaction to operative injury.

If fenestration is done by reducing surgical trauma to the minimum, one may say that impairment of high frequencies seen during the first postoperative period depends upon an alteration of sound transmission condition in the middle ear and not upon labyrinthine irritation.

We think that the concept of postoperative labyrinthitis should be modified as follows: Irritative stimuli normally act on the posterior labyrinth usually without extending to the anterior one. This appears to confirm the relative independence of the two portions of the labyrinth, and is of great clinical interest as it allows us to evaluate surgical injury.

Audiometric tests performed immediately after the operation can thus establish the extension of trauma and allow a prognosis. The behavior of bone conduction, of Weber's test, of speech audiometry as seen in 30 patients examined in our Clinic, even if accompanied by an impaired hearing capacity for high frequencies which is a sign of middle ear modification, guarantees a good recovery and a quick hearing improvement, thus eliminating the possibility of impairment of the labyrinth. Only if the Weber is lateralized to the ear which has not been operated upon, if bone conduction is impaired and if Fowler's test shows recruitment, one may think of a labyrinthitis. Immediate postoperative evaluation should not be limited to an investigation of hearing acuity by air conduction, as a fall of high tones may be due either to an alteration of the transmission apparatus or to a labyrinthitis.

SUMMARY

The author has examined the hearing behavior during the first postoperative period of labyrinthine fenestration.

A series of tests has been performed in order to clarify the importance of the so-called "postoperative aseptic labyrinthitis" in the impairment of hearing acuity which appears during the postoperative period.

Based on audiometric findings and on clinical and histological observations, the author stresses that the concept of labyrinthitis following fenestration should be modified: the trauma of a correctly performed operation brings forth an irritative stimulus which affects only the posterior labyrinth, while there appears to be no sign of extension to the anterior labyrinth.

The author believes that impairment of hearing for high frequencies from the third to the twentieth day should therefore not be related to a cochlear damage, but depends upon mechanical factors, which may be identified as an increase of mass of the new vibrating system owing to reactive edema of the tympanomeatal flap.

I am very grateful to Dr. Bocca, Director of the Audiologic Department "F. Lasagna" for his advice which has been of great help to me during the shaping and drawing up of my work.

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VII

THE BLOCKED BONE CONDUCTION TEST FOR DIFFERENTIAL DIAGNOSIS

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The Rinné test, the Gellé test[1] and Fowler's alternate binaural loudness balance test are methods available for differential diagnosis. However, these famous tests are somewhat inaccurate or inconvenient in clinical application, and, moreover, their mechanisms have not yet been completely clarified. First of all the Gellé test may be an interesting method that can detect disturbances of the middle ear vibratory system. However, it is difficult to apply air pressure to the external auditory canal without producing noise. This is the case in Macfarlan's modified method of the Gellé test.[2]

In studying the mechanism of the Gellé test the author found that the increased loudness in bone conduction obtained with the auditory canal blocked by a plastic plug is the same phenomenon as the decreased loudness in the Gellé test but opposite in effect. The increased loudness of the blocked BC has been reported by various authors, Pohlman and Kranz,[3] Békésy,[4] MacNally and Erickson,[5] Kelley and Reger,[6] Aubry, Causse and Chavanne,[7] Lierle and Reger,[8] Sullivan and Hodges,[9] etc.

As reported by some of the above mentioned authors, the author also observed that the threshold shift of bone conduction by blocking the external auditory canal was not only available for detection of the dysfunction of the middle ear vibratory system, but also for diagnosing nerve deafness. Moreover, the author found that central deafness including retrolabyrinthine deafness could be differentiated from the inner ear deafness by a combination of the two tests i.e., the blocked BC test and Fowler's balance test or difference limen test.

The author's acoustical experiments were made in a sound-proof room by using an audiometer which consisted of an oscillator with a frequency range of 100 to 10000 cps, a continuously variable attenuator and an indicator in decibel scale for output power of the audiometer. The bone conduction receiver used in this study was specially designed so as to suppress its AC below its BC in the whole range of 100-10000 cps when it was applied on the mastoid planum.

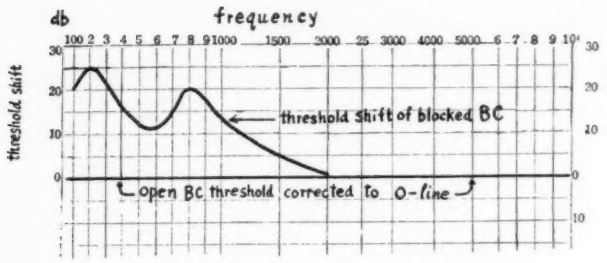

Fig. 1.—Shows threshold shift of blocked BC for a normal ear.

In this paper the author describes his own method of the blocked BC test, easily available for clinical audiometry, and explains the mechanism of the Gellé test as well as that of the blocked BC test.

The Author's Method of the Blocked BC Test.—A bone conduction receiver is placed on the mastoid planum of the tested ear, while the untested better ear is masked with a thyratron noise as done in the ordinary BC test. A BC test tone is increased from an inaudible intensity to one which the tested ear is just able to hear. The external auditory canal of the tested ear is blocked with a plastic plug perforated by a hole whose inner diameter is 1 mm. This reading should be checked. Then the plug is removed. Immediately after removal of the ear plug the test tone disappears in the tested ear, and after reinforcing the intensity of the test tone, the second threshold reading in the tested ear is obtained.

The difference in dbs between the two tests thus obtained is the numerical value which informs us as to amounts of conduction hearing loss. Such values will be about 20 to 30 db in a frequency range of 200 to 300 cps and about 15 to 25 db in a frequency range of 700 to 900 cps or rarely 1000 cps for pure nerve deafness as well as for normal ears as shown in Figure 1. On the other hand, these values will be reduced to less than 15 db or frequently to zero db in cases of conduction deafness. Even if the test tones are limited to the two frequencies 250 or 256 and 800 or 1000 (1024) cps this method can afford very accurate results.

Figure 1 is the detailed record of the blocked BC test for a normal ear. When the threshold shifts of the blocked BC are plotted on the ordinate of intensity above the zero line in respect to various frequencies of the test tones the frequency characteristic curve of the blocked BC is obtained. These curves for nerve deafness as well

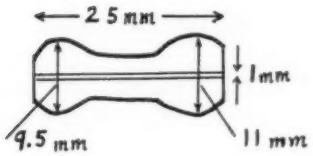

Fig. 2.—Shows one of the ear plugs for the author's method of the blocked BC test.

as normal ears appear in a frequency range of below 2000 or 2500 cps. There can be found two peaks in these curves; one of the two peaks at about 800 cps is considered to be due to the resonance of the tympanic membrane, and the other about 200 cps due to the resonance of the ossicular chain.

Some Important Findings of the Blocked BC Test.—For the sake of simplicity, let us call the frequency characteristic curve of the threshold shift of the blocked BC the "blocked BC curve." In the blocked BC test the author found that an inserted solid plastic plug which was air-tight sometimes produced a positive air pressure in the auditory canal and affected the function of the tympanic membrane so that unproportionally small threshold shifts or no shifts of the blocked BC were observed even in cases of normal ears. To avoid this error in the blocked BC test the author used plastic plugs of various sizes which were bored 1 mm in diameter through their central axis as shown in Figure 2.

The author compared a blocked BC curve obtained by using the perforated plug with that obtained by stopping the hold of the same plug with a small stopper without causing any pressure variation in the auditory canal of the same subject and could find no variation of the blocked BC curve between the former and the latter condition. Furthermore, the author compared the two blocked BC curves obtained respectively by a plug of suitable size and by another plug of relatively small size for the same subject's ear. The result is as shown in Figure 3.

Because of this it is necessary in performing the blocked BC test to use ear plugs of various sizes well fitted to each individual's auditory canal. The author uses two plugs of different sizes for the blocked BC test. One is 9.5 mm and 11 mm in outer diameter of its end portions which are inserted into the auditory canal, as shown in Figure 2. Another is 10 mm and 12 mm in its outer diameters. Both

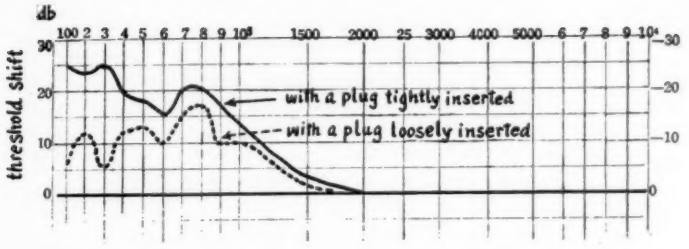

Fig. 3.—Shows a comparison between the results of the two blocked BC curves obtained by a tightly and a very loosely inserted plug in the same subject.

plugs are 25 mm in length and have holes 1 mm in diameter. The author has succeeded in making the blocked BC test very reliable by using such plugs.

The Blocked BC Curves in Cases of Nerve and Conduction Deafness.—The blocked BC curves are independent of any frequency characteristics of bone conduction receivers in cases of nerve as well as conduction deafness. Figure 4 shows such a relation between the blocked BC and AC curves in the same subject with binaural inner ear deafness.

However, the blocked BC curves depend upon the degrees of conduction loss due to the disturbed middle ear vibratory system. Figure 5 shows such a relationship between the blocked BC curves and the AC curves in the same subject with conduction loss. Atrophic scars of the ear drum were otoscopically observed in each ear of this subject but the scar in the right ear was much larger than that in the left while pneumatization of the mastoid process was very limited in both ears.

It is observed that the blocked BC curves as well as the clinical findings of this subject's ears correspond with the degree of AC hearing of both ears as shown in Figure 5.

The threshold shift of the blocked BC is inversely proportional to the degree of conduction loss and it becomes, in general, zero db in conduction loss of above 30 db. In other words, it is inversely proportional to the disparity between AC and BC curves in a combined type of deafness as well as in pure conduction deafness. The lowering or disappearance of the blocked BC curve due to middle ear lesion was frequently observed more markedly at the peak of about 800 cps than at the peak of about 200 cps as shown in Figure 6.

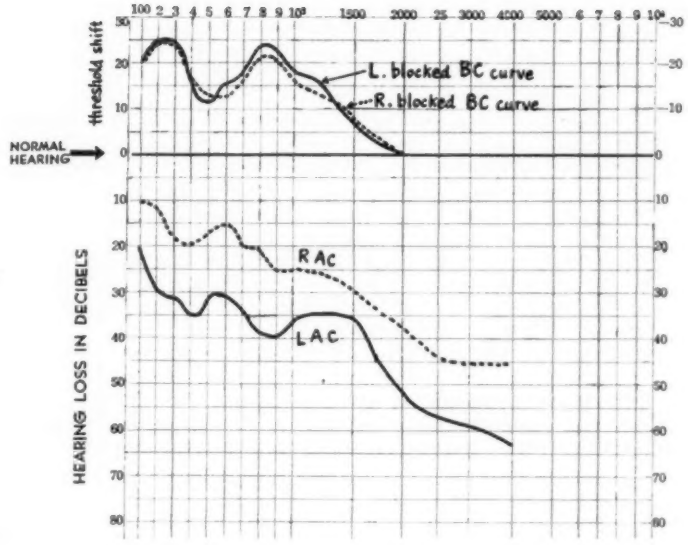

Fig. 4.—Shows the blocked BC curves of a subject with bilateral nerve deafness. These curves are independent of the respective nerve hearing losses.

When the middle ear lesion is slight the peak of about 200 cps sometimes remains intact while the peak of about 800 cps lowers or disappears. Opposite cases were also observed but rather rarely. For this reason it is clear that the blocked BC test should be checked by the two test tones 250 or 256 and 800 or 1000 (1024) cps.

The Relation Between the Blocked BC and the Gellé Test.—The results of this study were obtained by using the following apparatus as shown in Figure 7. In these experiments two kinds of ear plug were used which were different only in the diameter of their holes i.e., 1 mm and 4 mm, but equal in length. The experimental procedure is as follows: 1) with one of the test tones the open BC threshold is measured; 2) the blocked BC threshold is measured after inserting one of the two plugs; 3) the thresholds of the blocked BC are measured successively after applying air pressure of 30 and then 50 mm Hg through the hole of the same plug to the auditory canal.

Figure 8*a* shows the results with the plug whose hole is 1 mm in diameter. The altitudes of the points correspond with the thresholds for the respective test tones. The arrows indicate the decreased

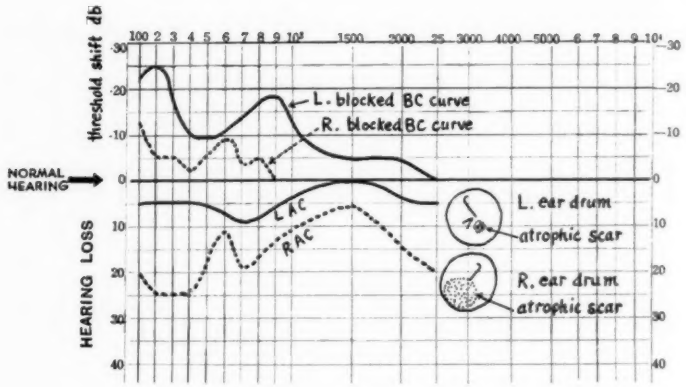

Fig. 5.—Shows the blocked BC curves and the AC curves in the same subject with conduction loss. The threshold shift of the blocked BC is dependent on conduction loss.

loudness of the Gellé test for respective test tones i.e., the Gellé effects produced by applying two kinds of positive air pressure, 30 and 50 mm Hg. The arrows of dotted line shows the effect for an air pressure of 30 mm Hg and those of continuous line the effect for an air pressure of 50 mm Hg. Figure 8*b* shows the results with the ear plug whose hole is 4 mm in diameter in the same subject as shown in Figure 8*a*.

From a comparison between the two figures it is understood that the Gellé effects are larger in the former than in the latter case in proportion to the magnitudes of the threshold shift of the blocked BC which depend upon the hole diameters of the plugs. Furthermore, a positive air pressure either of 30 or 50 mm Hg sometimes did not cause the large threshold shift of the blocked BC to vanish completely in the case of the plug with the 1 mm hole, while it did cause the smaller threshold shift to vanish completely in the case of the plug with the 4 mm hole.

In all the subjects the Gellé effects did not fall below the thresholds of the ordinary open BC by air pressures of either 30 or 50 mm Hg as shown in Figure 8*a* and *b*. From these results it can be said that the blocked BC test is exactly reverse in effect as compared with the Gellé test and that the former is superior to the latter since there is no need for the troublesome technique of applying positive air pressure to the auditory canal, which frequently leads to erroneous

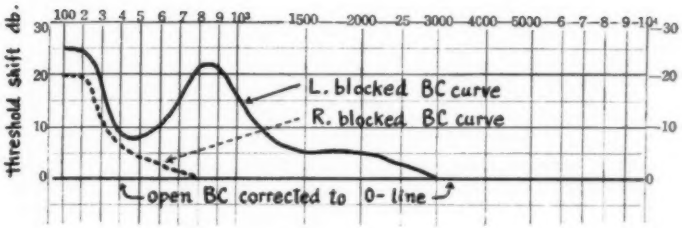

Fig. 6.—Shows the lowering or disappearance of the blocked BC curve at the peak about 800 cps in a case of slight middle ear lesion. The subject R. O.: Left ear drum is quite normal in appearance. Right ear drum has a large atrophic scar in its inferior quadrant.

results. In addition, there can be found a discrepancy of results between the two tests only in cases of tympanal perforation and the results of both tests are essentially equal in all other cases. In cases of tympanal perforation the blocked BC test shows that its threshold shifts are in inverse ratio to the diameter of the tympanic perforation, as shown in Figure 9 while the Gellé test produces no effect in the same cases. In this respect also the blocked BC test is more reliable that the Gellé test.

Consequently the author's method of the blocked BC test has proved to be very reliable. Its application to diagnosis of clinical otosclerosis is also proved to be exact; i.e. it shows no threshold shifts, 0 db, for the two test tones in a large number of cases of otosclerosis and rarely 5 db in an early stage of otosclerosis.

Combination of Onchi's Method of the Blocked BC Test with Fowler's Balance Test or Difference Limen Test.—Onchi's method of the blocked BC test detects a conduction component of hearing loss alone. Therefore, when decreased or no threshold shifts for the two test tones are detected in a subject it reveals that some part of the subject's hearing loss is conduction loss, but the other part, a component of nerve deafness, cannot be detected by it alone. When normal threshold shifts are detected in a subject it indicates that the subject's loss of hearing is due to nerve deafness, including central nerve deafness.

On the other hand, the difference limen test, as well as Fowler's balance test, reveals only a nerve component of hearing loss i.e., a pathologic condition of the hair cells. Consequently a combined type of deafness cannot be diagnosed by only one of the three tests,

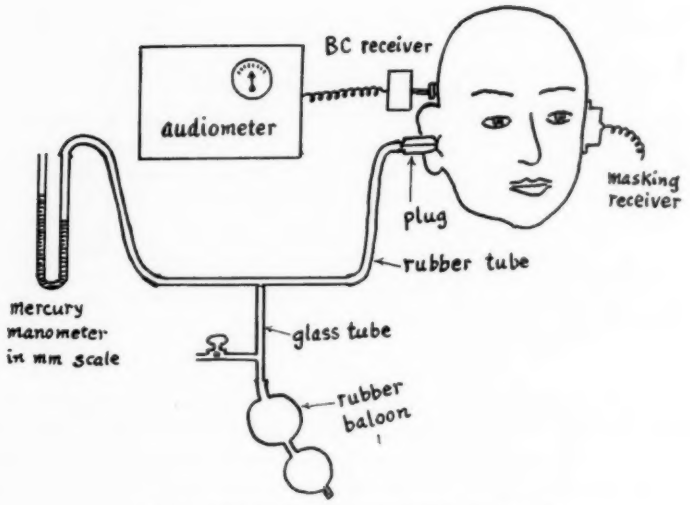

Fig. 7.—The author's apparatus for the Gellé test.

while it can be done by a combination of Onchi's method and Fowler's or different limen test.

In comparing the results of Onchi's method with those of the other two tests a standard common to the three tests should be set up. From clinical experiences the results of Onchi's method can be classified into three groups as follows: The first group with threshold shifts of above 15 db for the test tones 250 (256) and 800 cps or of above 10 db for the test tone 1000 (1024) cps instead of 800 cps is denoted Onchi's (+); the second group with the threshold shifts of below 15 db not including 0 db for the two test tones is denoted Onchi's (±); the third group with the threshold shift of 0 db for both test tones is denoted Onchi's (—).

Therefore, Onchi's (+) means the middle ear intact, Onchi's (±) the middle ear slightly affected, and Onchi's (—) the middle ear moderately or severely affected. From such a classification comparisons are made between the results of Onchi's method and those of the other two tests in respect to different types of deafness as described in Table 1.

From this table the possibility of differential diagnosis for central deafness can be expected. This deduction is at present proved

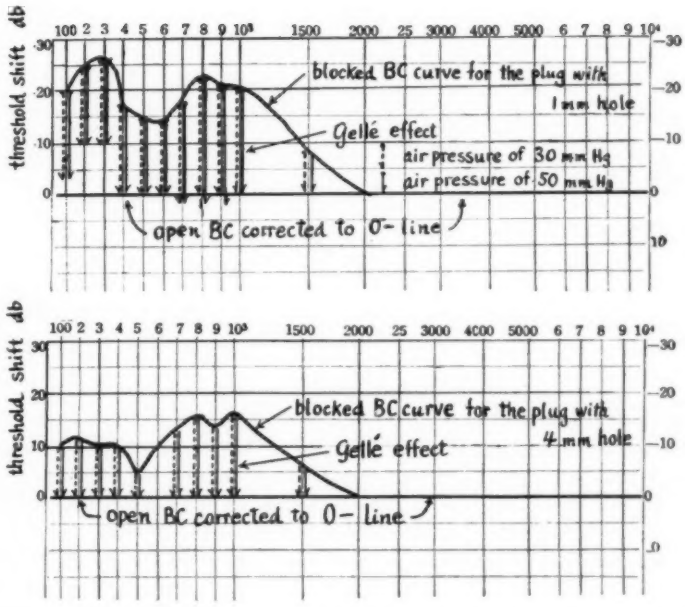

Fig. 8 *a* and *b*.—Shows the relation between the blocked BC and the Gellé effect regarding diameter of the plug hole.

by the author to be true in cases of central deafness due to brain or acusticus tumors.

The Mechanism of the Threshold Shift in the Blocked BC test.—This may be explained as shown in Figure 10. The sound waves emitted from a BC receiver on the mastoid process are propagated through the cranial bones in all directions. In this condition the five main paths of BC can be assumed, as A, B, C, D and E. The intensities of these paths are equal at their origin, namely the BC receiver. However, the intensities which arrive at the cochlea through these paths do not equal each other because there are different conduction losses in these paths.

According to the principle of reflection and refraction on a boundary of two media which are different in acoustical resistance or impedance, the smaller the difference of acoustical resistance or auditory canal would be reduced to about 30 to 40 db, as compared

TABLE I.

TYPE OF DEAFNESS	ONCHI'S METHOD	FOWLER'S RECRUITMENT	ABNORMALLY SMALL VALUE OF D. L.
Inner ear deafness	(+)	(+)	(+)
Conduction deafness	(—) or (±)	(—)	(—)
Combined type of d.	(—) or (±)	(+)	(+)
Central deafness	(+)	(—)	(—)

impedance between two media the less the conduction loss due to reflection of sounds caused by the boundary of the two media. From this principle the paths A and C have their large conduction loss on the surface of the auditory canal wall and that of the tympanic cavity wall respectively, because the difference of acoustical resistance is extremely large between air and bone or cartilaginous structure. The path B has also its large conduction loss at the limbus of the ear drum, because the ear drum is almost equal to air in acoustical impedance as reported by Troeger.[10] Similarly, the path E is considered to have its large conduction loss at the attaching points of the malleo-incudal rotatory axis and at those of the superior ligaments of the malleus head and incus corps, because the path E becomes very narrow at those points. The path D alone has a small conduction loss, because the difference of acoustical resistance between the cochlear fluid and the bone structure is much smaller than that between the air and the bone structure, and, moreover, its path is broader than the others. Therefore, the intensity through path D can be considered to be the main factor in BC hearing, assuming that the intensities of all the paths are equally reduced by pneumatization of the mastoid cells directly around their common origin i.e., a bone conduction receiver.

Among these paths, path A is the only one which is varied in conduction by blocking the auditory canal with an ear plug. When the sound waves arrive at the surface of the auditory canal wall through path A, almost all of the sound waves A are reflected on the surface of the wall into the cranial bones and only a very small fraction of the A waves is transmitted to the air in the auditory canal. Therefore, the sound intensity transmitted to the air in the

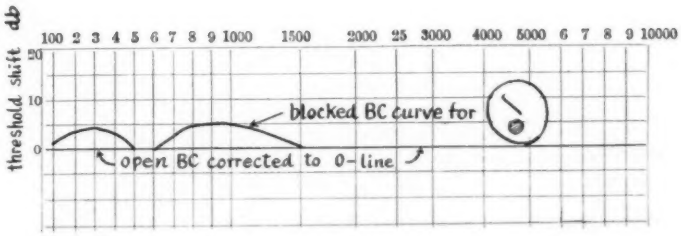

Fig. 9.—A discrepancy between the blocked BC test and the Gellé test. The former shows threshold shift but the latter produces no effect in the same subject with the ear drum perforated.

with the original intensity of the path A, according to its transmission coefficient $= 1 - (\frac{R_1 - R_2}{R_1 + R_2})^2 = 0.001$ or 0.0001, because R_1 the acoustical resistance of the auditory canal wall, may be between 15×10^4 and 83×10^4 cgs assuming that the acoustical resistance of the cartilaginous part of the auditory canal is equal to that of water (15×10^4 cgs), that of the osseous part to that of bone structure (83×10^4 cgs), and that of air R_2 is 40 cgs.

Moreover, the sound waves transmitted to the air in the auditory canal are divided into two parts (a_1 and a_2) when the auditory canal is open. Part a_1 alone is caught by the tympanic membrane and transmitted through the ossicular chain to the cochlea while part of a_2 is dissipated through the opening of the auditory canal to the outside air. Therefore, the intensity of a_1 may not result in appreciable reinforcement of the combined intensities in the cochlea of the other paths even if the intensity of a_1 is amplified by the middle ear vibratory system with its amplification factor of 40 db, because the intensity of a_1 is considered to be over 40 db less than that of path A.

However, when the opening of the auditory canal is blocked with an ear plug the sound waves of path A which are transmitted to the cochlea are increased by participation of the part, a_2, through the tympanic membrane and the ossicular chain. In addition, the acoustical resistance of the blocked air itself in the auditory canal is also increased by blocking more than that of the free air in the open auditory canal so that more sound energy is transmitted from the path A into the blocked auditory canal. Consequently such increased intensities in the blocked auditory canal would be (a_2+K)

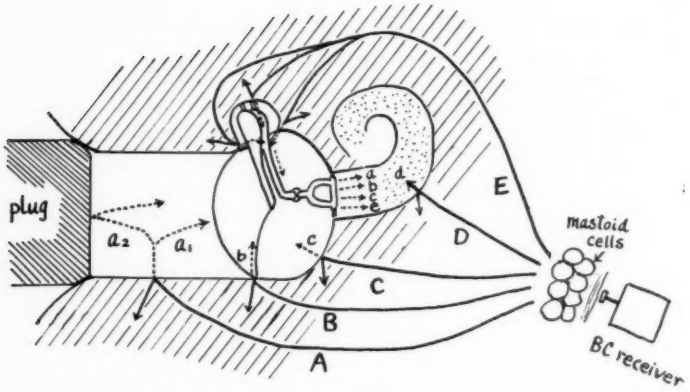

Fig. 10.—Shows the five main paths of BC assumed in the mechanism of the blocked BC.

db larger than that in the open auditory canal. These are then transmitted under the amplification function of the middle ear vibratory system to the cochlea.

If the factor K is about 10 db the increased intensities (a_1+a_2+K) would be amplified 20 db more by the middle ear vibratory system than the original intensity of path A as follows: 30 db loss by the reflection on the auditory canal wall, +10 db gain by the blocking, +40 db gain by the middle ear function totals 20 db gain in the cochlea. Moreover, the original intensity of the path D is decreased by the conduction loss between the cochlear fluid and the bone structure, but this conduction loss would be very small and not more than 5 db. Therefore, the difference between the intensities in the cochlea from paths A and D is about 25 db i.e., the threshold shift of the blocked BC. Figure 11 shows the relation between the intensities of the blocked and the open BC threshold with imaginary curves for clear comprehension.

From such a relation the amplification factor of the middle ear vibratory system is considered to be one of the variable factors in the blocked BC. This factor is different with frequencies of the test tones, because the middle ear consists of some resonance systems such as the tympanic membrane and the ossicular chain. Therefore, no threshold shift of the blocked BC occurs even in normal

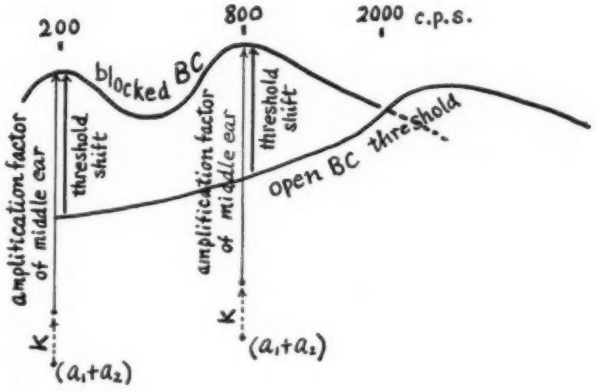

Fig. 11.—Shows the relation of intensity between the blocked and the open BC threshold with imaginary curves for the sake of illustration.

ears above a frequency of 2000 or 2500 cps as shown in Figures 1, 3, 4, 5, 6 and 8 where the intracochlear intensity of the path A tends to decrease with the decreased resonance of the middle ear vibratory system and is exceeded by the intracochlear intensity of path D.

The amplification factor of the middle ear vibratory system is decreased by applying air pressure on the tympanic membrane while the intracochlear intensity of path D is not varied by air pressure of below 50 mm Hg. From such a relation the threshold shift of the blocked BC is decreased by air pressure to a level of the intracochlear intensity of path D; i.e., the threshold of open BC in a frequency range of below 2000 or 2500 cps. This explains the fact that the less the threshold shift of the blocked BC is, the less is the effect of the Gellé test as shown in Figure 8*a* and *b*.

On the other hand, when an ear has its own amplification factor of the middle ear vibratory system, the Gellé effect as well as the threshold shift of the blocked BC is in inverse proportion to the diameter of the hole of the ear plug, because the larger the hole is the more the sounds are dissipated from the auditory canal to the outside air. This is also the case in Figure 8*a* and *b*.

When the hole of the ear plug is so small in diameter as to prevent leak of the test tones out of the auditory canal the threshold

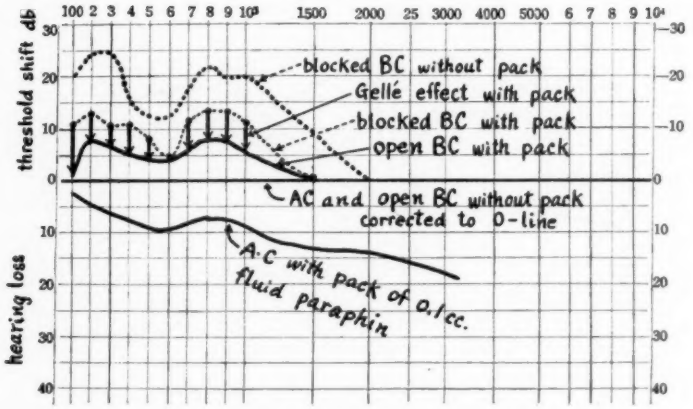

Fig. 12.—Shows blocked BC and Gellé test in a tympanic packing. The downward arrows are the Gellé effect under an air pressure of 30 mm Hg. These indicate the inverse relation between the threshold shift of blockd BC and the Gellé effect.

shifts for different test tones depend only on the amplification factors of the middle ear vibratory system for different test tones. Therefore, by using such a plug we find the two peaks of resonance in the blocked BC curves for nerve deafness with the middle ear intact, as well as for normal ears. One of the two peaks at about 800 cps is due to the resonance of the tympanic membrane and the other at about 200 cps may be due to the resonance of the ossicular chain. Consequently it can be seen that the variation of these two peaks is valuable for the detection of middle ear lesions.

Franke and his cooperators[11] state that the peak of 200 cps in the blocked BC shift is due to the resonance of jaw vibrations by a BC receiver. However, their observation indicates that the difference between the two threshold shifts of blocked BC with open and strongly closed mouth respectively does not exceed 3 db. This value of 3 db is insignificant as compared with about 25 db of normal threshold shift of blocked BC. In addition, the author could not find any difference between the two threshold shifts with the open and closed mouth in respect to the same subject when a BC receiver was placed on the mastoid planum instead of on the top of the head as done by Franke and his cooperators. From these facts the author

thinks that the peak of blocked BC shift at 200 cps may be due to the resonance of the ossicular chain.

To study further the mechanism of the blocked BC in cases of the affected middle ear vibratory system, the anterior half of the normal tympanic membrane was packed with a cotton ball soaked with 0.1 cc of fluid paraffin. In this condition the AC acuity as well as the blocked BC acuity was lowered by the tympanic packing while the open BC acuity was elevated in a frequency range of below 1500 cps as shown in Figure 12. Essentially the tympanic membrane has its smallest impedance in the middle ear vibratory system so that its amplification function is easily affected by a small positive or negative air pressure or a slight tympanic packing.

This results in lowering of AC and the threshold shift of the blocked BC in a case of tympanic packing. On the contrary, the transmission of sounds between the tympanic membrane and the auditory canal wall through path B is increased by the decreased difference of acoustical impedance which is caused by a drop of fluid paraffin between the two media. It causes an elevation of the open BC threshold in a frequency range of below 2000 cps where the increased intra-cochlear intensity of path B exceeds that of path D. These two contradictory factors make the threshold shift of the blocked BC smaller, or zero, because in this case the threshold shift of the blocked BC is the difference between the intracochlear intensity of path A and that of path B instead of path D in a frequency range of below 2000 cps. Similarly the effect of the Gellé test is also decreased, or zero, in cases of tympanic packing. From this experimental result it is considered that fibrous adhesion between the malleo-incudal heads and the epitympanal bony wall increases the transmission of path E more than that of path D while it affects the vibration of the tympanic membrane by retraction. This results in a negative result of the blocked BC as well as the Gellé test. In cases of clinical otosclerosis the stapes ankylosis decreases the transmissions of paths A, B, C and E more than that of path D so that it results in a negative effect of the Gellé as well as the blocked BC test.

The author's explanation for the mechanism of the blocked BC is made from the standpoint of molecular movement of the cochlear fluid. Therefore, it is assumed that counteraction due to a phase difference of 180 degrees is not caused in the cochlea among the above mentioned various bone conduction paths, because the path differences among these paths are much smaller in comparison with various wave lengths of the test tones.

SUMMARY

The author presents his own method of performing the blocked BC test with a plastic plug which has a hole 1 mm in diameter bored through its axis.

Two test tones are used, such as 250 (or 256) and 800 (or 1000 or 1024 cps if 800 cps is not provided in an audiometer).

The blocked BC test detects only conduction impairment, while Fowler's test and the D. L. test detect only nerve impairment.

Differential diagnosis of central deafness is possible by using a combination of the blocked BC test and Fowler's test or the D. L. test.

The mechanism of the Gellé test as well as the blocked BC test is explained.

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VIII

PROPHYLAXIS OF EXTERNAL OTITIS

PRELIMINARY REPORT

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In order to obtain more information regarding the etiology, pathology and treatment of diseases involving the external ear, an integrated study of external otitis was initiated at Washington University School of Medicine under the auspices of the Air Forces. Biochemical, histological, pathological and bacteriological techniques have been employed. From the information obtained, a better understanding of the etiology and pathogenesis of certain categories of these diseases has been obtained and some clarification of the diverse therapeutic measures has resulted.

A significant by-product of these investigations has been a focusing of attention upon the importance of prophylactic therapy. Although there has been sporadic use of ear protectors and medications in an attempt to prevent infections of the ear canal in swimmers, no published reports are available at this time which describe controlled studies of this problem. It is the purpose of this report to present a brief review of some of the investigative work which has given impetus to this study and which has formed the basis for the development of several artificial ear wax preparations which are now being field tested with the Navy. It is to be emphasized that this study is still in its preliminary stage and it is our hope that this report will stimulate others to investigate this fertile field.

PATHOLOGY AND BACTERIOLOGY

Although all the pathological evidence has not been obtained, it is the opinion of one of the authors (BHS) that there is sufficient

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evidence to justify the following concept of pathogenesis in certain forms of acute and chronic external otitis.[1, 2] As a result of persistent high temperature and humidity and repeated wetting of the skin by frequent swimming or bathing there is produced in certain susceptible individuals an edema or thickening of the top layers of the skin of the ear canal. This results in the plugging of the ducts of the apocine and sebaceous glands and the skin of the ear canals is deprived of its normal oily protective coating. If the hot, humid period continues and these glands are unable to pour their secretions onto the surface, there develops a pre-inflammatory state consisting of an itchy, dry, scaly skin devoid of sufficient lipids.

Such dry ichthyotic skin is constantly irritated by rubbing, scratching, and the introduction of foreign bodies and irritating medications. These are ideal conditions for bacterial growth. The ubiquitous Gram-negative bacilli or fungi are readily introduced by fingers, foreign bodies or contaminated water. None of the bacteriostatic or fungistatic secretions from the epidermal glands are present on the surface of the skin to retard the growth of these exogenous organisms so that rapid superimposed inflammation results.

BIOCHEMISTRY

The biochemical approach to this problem is directed chiefly towards an understanding of the chemical nature of the normal secretions found in the external auditory canal. If micro-chemical techniques can be developed for analyzing the essential basic elements in normal secretions, then it will be possible to determine what components are absent in the diseased state which precedes the onset of acute inflammations of the ear canal. This is important because substances present in cerumen may well have bactericidal or fungicidal properties which maintain the normal healthy physiological and biochemical state of the epidermis. These considerations are supported by many studies including Rothman et al,[3] Burtenshaw,[4] Ricketts et al[5] and Wheatley.[6]

Our investigations[7, 8] of the chemistry of cerumen have been concerned chiefly with the quantitative and qualitative estimation of the lipid and amino acid fractions. Due to the small amounts of cerumen available, paper chromatography has been employed for the detection of these two classes of substances.

The results obtained with chromatography indicate that untreated cerumen contains tyrosine, leucine, isoleucine, valine, alanine, threonine, serine, glutamic acid, aspartic acid, glycine, gamma-amino butyric acid, arginine, and lysine. Fat-free cerumen contains fewer free amino acids than does untreated ear wax; and these were aspartic

acid, glycine, serine, alanine, threonine, valine, the leucines, tyrosine and beta-alanine. However, defatted cerumen which was hydrolyzed with 6 N HCl showed, in addition to those amino acids present in the free state, the following: methionine, taurine, phenylalanine, arginine, lysine, proline, threonine, and glucosamine. These latter amino acids result from the hydrolysis of proteins and only the presence of glucosamine is unusual.

So little work has been done on paper chromatography of fatty acids that the results reported here are only tentative in that none of the fatty acids of cerumen could be definitely characterized. However, since certain known pure fatty acids migrate on the paper strips to specific levels whereas other pure fatty acids remain at the origin on the paper strips, it is possible to obtain some information on the presence of some of these fatty acids in cerumen.

For example, eleostearic, arachidic, behenic, lignoceric and stearic acids remain at the origin of the paper strips as does a portion of the fatty acids of cerumen. Cerotic, erucic, and myristic acids migrate on the paper strips and part of the fatty acid mixture of cerumen migrates to about the same extent. It is therefore possible to assume that the fatty acids of cerumen may contain one or more of the fatty acids which remain at the origin, or which migrate.

COMMENT

On the basis of the findings in the literature, particularly those of Wheatley, Burtenshaw and Ricketts, and our own clinical and chemical observations, an artificial ear wax has been compounded for the purpose of treating the so-called dry pre-inflammatory stage of external otitis, thus preventing the superimposed acute disease. After more information is available regarding the pathogenesis of the disease and the specific components present in normal secretions and absent in the diseased state, more definitive chemical treatment will be possible. Until this additional information is available, it is suggested that synthetic ear wax might well contain the following groups of compounds[9] suspended in a proper vehicle:

(1) The fatty acids stearic, cerotic, erucic, myristic and palmitic.

(2) The amino acids tyrosine, leucine, isoleucine, valine, alanine, threonine, serine, glutamic acid, aspartic acid, glycine, gamma-amino butyric acid, arginine, and lysine.

(3) The metals potassium, sodium, calcium, magnesium, zinc, iron and copper.

(4) The following vitamins and organic compounds: ascorbic acid, biotin, choline, inositol, pyridoxine, urea, citric acid, delta^7-cholestanol, cholesterol, squalene, paraffins, triglycerides, cholesterol esters, and perhaps some of the other well known sterols.

CONCLUSIONS

Diseases of the external ear are being investigated from a chemical, pathological, histological and bacteriological point of view. The results of these studies are being applied on a clinical level for the prevention of external otitis. On the basis of the information available concerning the chemistry of the epidermis, together with that which is known about the chemistry of cerumen, an artificial ear wax has been prepared and is being field tested for the treatment of the itchy, dry, ichthyotic state which precedes acute inflammation of the skin of the external auditory canal.

It is hoped that the investigative work of which this paper is a brief preliminary report will lead to the development of a prophylactic preparation which will prevent many of the diseases of the external ear.

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IX

REPAIR OF TYMPANIC MEMBRANE PERFORATIONS WITH HUMAN AMNIOTIC MEMBRANE

REPORT OF FIFTY-THREE CASES

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The problems associated with perforations of the tympanic membrane have been brought into sharper focus in recent years by the mobilization of huge numbers of men for military service. The author became particularly interested in closing such perforations during his service with the Army and Air Force. These disabilities often assume an even greater importance in military than in civilian life. The man with a perforated ear drum has certain limitations in the performance of many duties, is prone to recurrences of otitis media and always has a justifiable excuse for going on sick call when scheduled for an unwanted duty. In addition permanent hearing losses incurred while in the service are the basis of many claims against the Government for compensation. Many otherwise healthy men are disqualified for duty because of perforated tympanic membranes.

A review of medical literature revealed an age-old interest among physicians in this problem and caused the author to seek a modern answer.

HISTORICAL

Since the classical dissections of Vesalius were published in De Humani Corporis Fabrica in 1543[1] the medical world has realized the likeness of the middle ear to a small drum. It was not until the discovery of the third ossicle, the stapes, by Gian Fillipo of Ingrassia in 1548 that the function of the ossicular chain was fully understood. Later anatomists and physiologists notably Antonius Scarpa (1789),

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Corti[2] (1851) and Helmholtz[3] (1863) further enlarged upon the anatomy and physiology of hearing.

Investigations continue unceasingly and in 1941 Van Dishoeck[4] published his experiment on the measurements of the tension of the tympanic membrane. Secondi[5] (1951) by dissection methods and the use of polarized light was able to demonstrate the disposition and character of the radial and parabolic fibers of the lamina propria.

One thing has been apparent from the beginning: that the tiny drumskin, the tympanic membrane, must be intact in order to have a functionally perfect acoustic organ. Any perforation or loss of a portion of this membrane must result in some impairment of normal function.

The problem of restoring the damaged tympanic membrane to its best possible functional state has been met in a variety of ingenious ways since Marcus Banzer[6] in 1640 proposed the use of an ivory tube covered with a membrane of pig's bladder. Since that time much effort has been directed toward finding an artificial substitute for the normal tympanic membrane.

In 1842 Yearsley[7] noted that the presence of a pledget of cotton wool in the canal of a patient with a perforation improved her hearing. In 1853 Toynbee[8] reported making artificial membranes of thin layers of India-rubber and gutta-percha to which was attached a fine wire for manipulating it into place. The success of these devices led to the development of similar artificial drums such as the ellipitical rubber tympanum of Clark[9] in 1859, the sized paper disk of Blake[10] in 1876, the elastic collodion membrane of Pollack[11] in 1882, the egg membrane of Guranowski[12] in 1887, the collodion tubule of Isaacs[13] in 1925 and the cellophane disks of Nasiell[14] in 1934. The most recent prosthesis presented is that of Pohlman[15] consisting of a conical cylinder made of the plastic Koragel.

For some thirty to forty years after the announcements of Yearsley and Toynbee many claims and counter-claims were made for the efficacy of the artificial tympanic membranes. Aided by the unscrupulous and fraudulent claims of various non-medical manufacturers of several kinds of these devices they fell into some disrepute. They were less frequently used by otologists until Barclay[16] in 1890 pointed out that proper applications of Blake's paper disk aided in the actual closure of perforations of the tympanic membrane. Once the medical profession was convinced that perforations of the drum-head could be closed, a revived interest was evoked. Roosa[17] and Politzer[18] applied a silver nitrate stick to the edges of

the perforation to stimulate healing. In 1895 Okuneff[19] reported the successful closure of certain types of perforations by the application of trichloracetic acid to the free edges. Dunlop[20] reported successful closure of fifteen cases by this method in 1917. As recently as 1951 Adams[21] showed audiometric improvement in cases successfully closed with trichloracetic acid.

Numerous other methods of closure have been suggested such as Griot's[22] application of heated air with a Politzer bag via a eustachian catheter to the drum to stimulate healing, the Cargile's membrane (sheeps mesentery) of Stinson[23] applied after cauterizing the edges by trichloracetic acid and Ruskin's[24] method of forcing dental gold cylinders through the perforation. Linn[25] cauterized the edges with trichloracetic acid, then applied a pledget of cotton which had been dipped into "Protonuclein Dusting Powder" and irradiated with ultra-violet light. "Euthymol" was then dropped on this pledget twice daily. In 1945 Fox[26] stated that he had closed several dozen perforations with Cargile's membrane and trichloracetic acid. Folbre[27] mentions fifteen cases of traumatic perforation due to blast injury in World War II which failed to show evidence of closing after being dry for two weeks. Eleven of these he was able to close by placing cigarette paper wetted with saline over the defect. Then trichloracetic acid was applied to the paper and allowed to seep through to the edges of the perforation. Steinmann[28] noted that cellophane patches 0.02 mm thick which he used as a prosthesis sometimes encouraged the perforation to close. Unger[29] describes the use of gold foil patches covered with scarlet red ointment to regenerate the margins of the perforations. The disk is removed every day for aeration of the middle ear and renewal of the ointment.

EXPERIENCE WITH OLDER METHODS

Several of the suggested methods for restoring hearing with artificial ear drums were tried with indifferent success and were given up as impractical for military personnel for many reasons. At best these devices were serviceable only as long as these transient patients had access to the care of an otologist with some experience with these appliances. At worst they caused recurrences of otitis media and externa, exposing the patient to dangers of mastoiditis and other attendant complications. Thus the decision was made to close these perforations in all cases where this was possible.

Applications of trichloracetic acid to the margins in the manner of Okuneff and Dunlop and Schuknecht[30] were successful in some cases. The silver nitrate method of Roosa and Politzer also brought

about a few closures. The main difficulties in these cases were the large number of treatments necessary in all but the smallest perforations, the objection of some patients to the slight discomfort of the treatment, the frequency of intervening infection (17 per cent in 42 patients) and the fact that hearing was not significantly improved until the perforation was completely closed, or nearly so.

It was next decided to use the disks of sized paper of Blake and the cigarette paper and trichloracetic acid according to Folbre's method. Both methods were effective but an objection to the former was the impossibility of seeing the progress of the perforation when covered by opaque paper and to the latter the partial destruction of the cigarette paper by the trichloracetic acid. Also the sized paper had a marked tendency to "wander" from the site of the perforation usually to the posterior canal wall. Cellophane was an even worse offender in this respect. The observations of Stinson[31] concerning the "escalatory effect" of the epidermis of the drum-head seem to be well corroborated by these migrations and they take place generally according to the laws set down by him. In three of six cases a new cover had to be replaced over the perforation and in one case five re-applications were required.

PROPERTIES AND PREPARATION OF AMNIOTIC MEMBRANE

Upon observing some placentas in the pathology laboratory the author noticed some of the properties of human amniotic membrane. It was at once transparent, tough, thin and slightly elastic. The chorion which was darker, thicker, more opaque and friable could be scraped from it with little difficulty. Large patches of even texture were easily obtained. Further investigation showed that the fetal side of the amnion is composed of ectoderm while the chorionic side is composed of mesoderm[32] which adheres quite tenaciously to the chorionic mesodermal layer and to almost anything else it comes into contact with. It was this adhesive property which seemed particularly desirable and was the main reason for deciding to use this membrane to repair perforated tympanic membrane.

A search of medical literature revealed that prepared amniotic membrane had been used in general surgery for various purposes since 1937. Its first reported use in otologic surgery was by M. Sugar[33] of Edinburgh in 1944. He called the material "amnioplastin" and prepared it in a different manner than is described in this paper. It was used to line the mastoid cavity after a radical mastoid operation much as we use the skin graft. Its main virtue seemed to be that it kept down luxuriant granulations thus cutting down the length and

TABLE I (condensed*).

Age	Closure	Hearing loss in decibels at frequencies of: 125	250	500	1000	2000	4000	8000	Days to Close
Average 24	Pre	26	30	27	28	26	27	30	
	Post	11	9	10	9	7	9	15	43
Improvement		15	21	17	19	19	18	15	

(*Table I in the MS., from which this table is condensed, contains the detailed pre- and post-repair audiograms of 53 cases.)

amount of postoperative care necessary. A dry ear was gained in 75 per cent of the cases.

After some experimenting it was found that amnion in its original state was impossible to handle in a practical manner. Eventually the following method for preparing the membranes was envolved:

The placenta from a normal birth of a healthy child from a healthy mother is selected. Several large pieces of the combined amnion and chorion of even texture and thickness, free of any defects, plaques or blood vessels are cut free from the placenta. These pieces are then placed in a sterile, sealed, brown glass jar containing Ringer's solution with one part merthiolate to every thousand parts solution. After 24 hours no bacteria have been able to be cultured from the solution containing the membranes, and sterility to the usual culture methods has been retained for as long as four weeks. In all of the steps following the sterilization, the membranes should be handled by a strict aseptic technique. The technician should wear cap, mask and sterile rubber gloves and work on a table covered with several thickness of sterile sheets or towels in a small closed-off, draft-free room. The membranes are first stretched out on a sterile towel to absorb most of the solution. Next the chorion is separated from the amnion by stripping with a sterile forceps and scraping with a dull all-metal table knife. It is necessary to remember which side the chorion was adherent to, since this is the mesodermal surface which will be applied against the tympanic membrane. The amnion is now cut into roughly circular pieces of such a size as to fit conveniently into a selected Petri dish. The Petri dish has previously been fitted with a piece of corrugated cardboard thoroughly im-

TABLE II.
STATUS OF PATIENTS WITH SUCCESSFUL CLOSURE OF PERFORATIONS.

	NO.	PER CENT
Military Personnel	34	70.83
Male	24	50.00
Female	10	20.83
Dependents of Military Personnel	10	20.84
Retired Military Personnel	4	8.33
Total	48	100.00

pregnated with paraffin and the whole sterilized in a hospital autoclave. Next a piece of damp membrane is stretched over the paraffined cardboard and held in place with sterile pins bent at a right angle to permit closing the lid over them in the Petri dish. It is important to place the ectodermal (fetal) side of the amnion against the paraffined cardboard, both to lessen the likelihood of adhesion and to prevent loss of the more sticky mesoderm. The cardboard and stretched membrane together with a small waxed paper container of calcium chloride to absorb moisture, are placed within the Petri dish and the cover replaced. This is allowed to dry for 48 hours or longer. If moisture condenses on the lid and sides of the dish the cardboard and membranes with a fresh container of calcium chloride are removed to another dry sterile dish. This is seldom necessary if the membrane was fairly well dried between towels upon removal from solution. One transfer at most is necessary.

After the membrane is thoroughly dried it presents a thin transparent stiff appearance somewhat like cellophane and is quite as easily handled. Three all metal punch dies of the kind used by leather workers, numbers 6, 7, and 8 which are 5/32nds, 3/16ths and 1/4th of an inch in diameter respectively are used to punch out disks of membrane of various sizes. One of each of these sizes is placed, ectodermal side up in the center of a square of sterile waxed paper. The paper is now folded in the same way a pharmacist puts up powders and are stored in another sterile Petri dish until needed.

Although this procedure may seem somewhat tedious and involved it can be done quite simply and easily by any person trained

TABLE III.
RINNE TESTS.
512 C. P. S. TUNING FORK AND AUDIOGRAM AT 500 C. P. S.

Preclosure (This includes all 53 cases.)		
AC>BC (positive Rinne)	11	20.75%
BC>AC (negative Rinne)	42	79.25%
Preclosure (Calculated for the 48 successful cases.)		
AC>BC (positive Rinne)	9	18.75%
BC>AC (negative Rinne)	39	81.25%
Postclosure (This includes only the 48 successful cases.)		
AC>BC (positive Rinne)	37	77.08%
BC>AC (negative Rinne)	11	22.92%
Returned from abnormal status (negative Rinne) to normal status (positive Rinne).	28 or 75.6%	
Failed to return from abnormal status (negative negative Rinne) to normal status (positive Rinne).	9 or 24.4%	

in sterile technique. In one operation sufficient numbers of the membranes can be made to last for the anticipated needs of six months or more. We have used these membranes prepared more than a year previously with good results.

METHOD OF APPLICATION

The patient's ear canal is prepared by the removal of all cerumen and desquamating epithelium with small pieces of cotton wound on a thin malleable copper wire probe. Next a tampon of sterile cotton saturated with Grey's solution (10 per cent cocaine hydrochloride in equal parts 95 per cent ethyl alcohol and aniline oil) is placed in the canal against the drum-skin. This acts both to sterilize the canal and to anesthetize the tympanic membrane. It also stimulates a desired hyperemia of the drum-head and surrounding parts by a mild irritative effect. This is allowed to remain in place ten minutes. Next about 3 mm of the tip of a fine probe tightly wrapped with cotton is dipped into a solution of 50 per cent trichloracetic acid. Any excess is removed by touching the probe to a fine piece of gauze. Then, protecting most of the canal with a metal speculum, the edges of the perforation are touched with the acid bearing cotton. About

0.5 mm of whitened margin around the whole circumference of the perforation is most desirable. Now a proper sized disk of amniotic membrane is selected and picked up with the applicator. This instrument consists of #24 steel wire about 10 cm long, the end of which has been fashioned by a small pointed pliers into a loop of suitable size. This loop is then bent at right angles to the rest of the wire so that the whole resembles a miniature branding iron. The opposite handle end of the wire may be looped, bound with adhesive tape, or placed in a cork or wood handle to provide a better grip for the fingertips. The loop is flamed in an alcohol lamp to sterilize it, then dipped into a drop of sterile mineral oil to give it an adhesive quality. The oiled loop is then applied to the ectodermal surface of the selected amnion disk which at once adheres to the wire. The ear canal is carefully straightened out and the largest possible sized metal speculum is introduced as deeply into the canal as the patient can reasonably tolerate. The disk is carefully guided through the speculum under direct vision and placed squarely over the perforation. It immediately becomes adherent to the tympanic membrane since the more sticky mesodermal surface is presented to it. A few practice attempts are necessary to learn to avoid brushing the disk off on the canal wall. If the amnion does not completely cover the perforation, it can sometimes be teased into proper position with a cotton tipped applicator. Usually however, due to its extreme adhesive properties, it is necessary to remove the disk completely and attempt a reapplication. When the disk is in proper position, it may be difficult to see it well because of its transparency, particularly after it has been slightly dampened with secretion from the cauterized drum-head, or with the mineral oil. However, its presence can be detected by a definite light reflex and the patient senses at once when the perforation has been completely occluded. He invariably feels that his ear has come "alive." Not only are incidental sounds in the room heard more clearly, but his ear also feels more comfortable and he is most agreeably surprised.

RESULTS

In all cases the ear had been free of drainage for at least two weeks and usually longer. There was no evidence of any spontaneous closure or lessening of the size of the perforation for at least two weeks. Many membranes had been ruptured for several years. Twenty one (39.81 per cent) had been open more than one year.

From previous experience it had been determined that unless there was some visible rim of tympanic membrane (at least 1 mm wide) surrounding the perforation, it was not likely that the drum-head could be repaired. For that reason it was decided to use

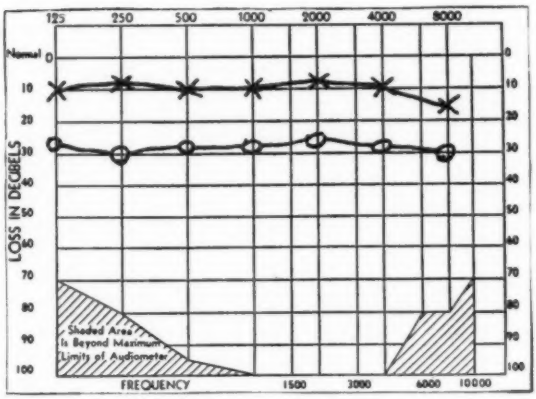

Fig. 1.—A composite audiogram for the forty-five cases successfully closed.

O——O average hearing loss before closure.

X——X average hearing loss after closure.

this method only on central perforations and not on marginal ones. For the same reasons only those perforations in the pars tensa were attempted. Despite this resolve and encouraged by previous good results with the central perforations, several attempts were made to close marginal ones. These endeavors were attended by indifferent success. There was some questionable degree of closure in a case or two but never a complete closure. These cases are not included in this analysis of 53 consecutive selected cases of perforated tympanic membranes.

Table I is an analysis of these 53 cases of attempted closure and the 48 successes, from the standpoint of the age of the patient, the changes in the audiograms before and after closure and the number of days necessary to effect a closure.

Table II indicates the military status of the patients with successful closures since this work was done on patients seen in military hospitals and clinics.

Table III shows the results of the Rinne tests before and after closures.

Surprisingly enough the average hearing loss in these cases was no more than 30 decibels at any frequency and the resulting curve (Fig. 1) is almost a straight line, the greatest loss being at frequencies

of 250 and 8000 c. p. s. (30 decibels) and the smallest at 2000 c. p. s. frequency (26 decibels), with a variance of only 4 decibels. The average improvement was 18 decibels and the resulting mean curve is also a straight line.

There are great differences in individual cases. However the greatest improvement in any frequency in any ear never exceeded 40 decibels. In many ears the initial hearing loss was negligible as far as useful ranges were concerned, and the resulting improvements were quite undramatic. This does not detract from the other obvious benefits accruing to the patient when his tympanic membrane is intact.

The advantages stemming from an increased feeling of well-being and the wider latitude of otologically safe activities are more difficult to measure. Such normal activities as swimming, shampooing the hair and taking a shower-bath are constant sources of danger to the middle ear unprotected by an intact tympanic membrane. Most of these people have learned by bitter experience that any time water or other foreign material enters the tympanum through a perforation, there is a likelihood of reinfection of the tympanum with the attendant complications. Thus an "ear consciousness" is developed which in a large measure detracts from many of the simple pleasures of everyday living. These sufferers will sometimes go to amazing lengths to prevent reinfection. Once the perforation is closed and the source of potential trouble removed, the afflicted person has an understandable psychological uplift. Add to this an improvement in hearing and the result is a truly grateful patient.

The length of time necessary to effect a closure varied from 7 days to 210 days, with an average of 43 days required for closure.

The question of which of the three layers of the tympanic membrane entered into the closure could not be fully determined by observations made in these cases. Without question the squamous epithelium of the external membrane surface closed completely in all successful closures. In many large perforations it was obvious that the new cover was thinner, more transparent and bulged to a greater degree than the "normal" drum-head with the Valsalva maneuver. Whether or not there was a regeneration of any of the middle fibrous layers with any elastic fibers is impossible to say.

It is quite likely that the simple cuboidal epithelium of the middle ear also advanced across the defect to line the inner side of the epithelium. Possibly some of the more deeply situated squamous epithelium cells underwent a metastasis. This is, however, purely speculative for there was no opportunity for histopathologic examination in any case.

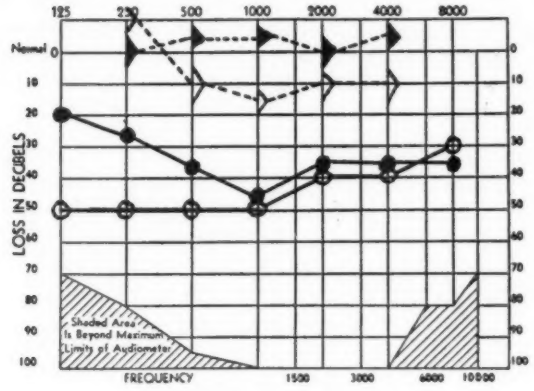

Fig. 2.—Otosclerosis right ear.

O——O air conduction pre-fenestration.

●——● air conduction post-fenestration with perforated tympanic membrane.

>---> bone conduction pre-fenestration.

▸---▸ bone conduction post-fenestration with perforated tympanic membrane.

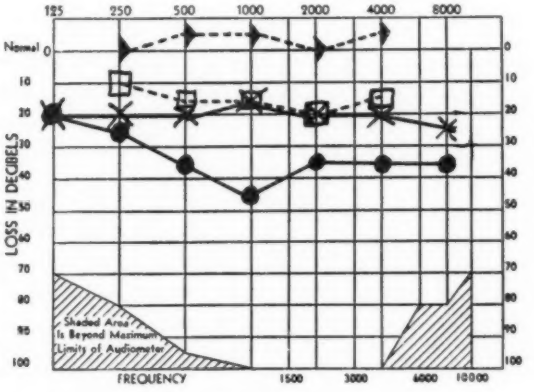

Fig. 3.—Otosclerosis right ear post-operatively.

●——● air conduction post-fenestration with perforated tympanic membrane.

X——X air conduction post-fenestration with perforation closed.

▸---▸ bone conduction post-fenestration with perforated tympanic membrane.

□——□ bone conduction post-fenestration with perforation closed.

Some of the smaller perforations were noted to heal with little or no evidence of scarring or differences in transparency or pressure resistance. In these cases it was felt that all layers fully regenerated although it was impossible to show that the elastic fibers of the middle layers had resumed their normal relationships.

Although no attempt was made to measure accurately the size of the perforation, it was noted that there is a definite relationship between the size of the perforation, the amount of hearing loss and its healing ability. The larger the perforation, the greater was the hearing loss; the longer it took to heal, the more was it likely to result in a thin flaccid scar.

The youngest patient in this series was three years and nine months of age, and the oldest sixty years, with an average age of 24 years. However, no definite correlation could be obtained between the age and the healing ability. This particular group was composed largely of military personnel (male and female) on active duty, and their dependents. There were a few retired personnel included but the mean was certainly composed of a cross section of the youngest, healthiest part of the American population (Table II).

An interesting finding was the correlation between the relative changes of air conduction and bone conduction in the perforated and closed state of the same tympanic membrane, as shown both by audigram and the 512 c. p. s. tuning fork (Table III).

All of the cases failing to reverse their Rinne test showed either a mixed type of deafness or some destruction of the manubrium of the malleus.

Figures 2 and 3 refer to a patient with bilateral otosclerosis on whom a fenestration type operation was performed on the right ear. The operation was successful except that it was complicated by a perforation of the tympanic membrane. When this perforation was covered with the amniotic membrane an immediate increase of the hearing to a useful level was noted. This improvement persisted and did not change appreciably after the tympanic membrane closed.

Some interesting facts are noted in this case. Shortly after operation and before the perforated tympanic membrane was closed, there was a definite improvement in air conduction, particularly in the lower frequencies. In the most important conversational frequencies (1000 c. p. s. to 4000 c. p. s.) there was only five decibels of improvement. Remarkably there was also a marked amount of increase in bone conduction (Fig. 2). After the perforation was closed (Fig. 3) the air conduction improved to a very useful level

of about 20 decibels loss in all frequencies and the bone conduction closely approximated this curve. Examination with tuning forks showed an indifferent Rinne test (i.e. air conduction equaled bone conduction). Certainly here is a classic example of the role played by perforations of the tympanic membrane in both air and bone conduction.

The failures of closure in three of these cases was due directly to repeated infections. These infections resulted both from the inadequacy of the treatment in effacing all foci of infection from the middle ear, mastoid cavities, eustachian tube and the upper portion of the respiratory tract and from the inability of the patient to prevent foreign material especially water, from entering the middle ear via the canal.

Two failures could not be explained. The first was in a female aged 46 and the second in a male aged 20. Although there was no evidence of reinfection and no drainage the perforation never changed appreciably in size despite reapplications and a suitable length of time (eight months and six months respectively). It may have been either that there was not sufficient stimulation to the epithelium to encourage proliferation or that the epithelium merely regrew over the cauterized edge to join with the epithlium of the middle ear instead of bridging over the perforation along the scaffold of the amniotic membrane.

In several other cases the process was temporarily interrupted by reinfection and mucoid (allergic?) accumulations in the middle ear. These perforations however continued to grow smaller as soon as the infection was resolved. In a few cases it seemed that reinfection actually stimulated and increased the rate of healing, although of course these perforations had remained open with no evidence of lessened diameter for varying lengths of time (two weeks to several years).

SUMMARY

A new method of closing perforations of the tympanic membrane with human chorionic membrane is described.

Previously described methods of closure are discussed and some of their shortcomings reviewed.

Fifty-three cases of perforated tympanic membranes are presented. These cases were selected on the basis of having been free from evidence of infection and drainage for at least two weeks. They showed no evidence of spontaneous improvement during this

time. There was at least a small rim of tympanic membrane present around the entire perforation.

Forty-eight of these perforations were successfully closed. The average improvement in the air conduction audiogram in all frequencies was eighteen decibels.

Of these cases 81.25 per cent showed a negative Rinne test before closure. Of those previously Rinne negative 75:6 per cent changed to a positive Rinne after closure.

A case of perforated tympanic membrane following a fenestration operation, and the benefits resulting from closure by this new method, are cited.

It is felt that this method of closing perforated tympanic membranes has definite advantages and deserves further trial by otologists.

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X

EAR, NOSE AND THROAT PROBLEMS IN THE UNITED STATES AIR FORCE

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Otolaryngology was among the first of the formal specialties to lend a hand in the new field of aviation medicine. In selecting the flyer, otolaryngologic defects are exceeded only by ophthalmologic and neuropsychiatric defects as causes of rejection. In the field of maintenance of the flyer, otolaryngology leads them all, which is true also of civilian practice. Lierle[1] found from questionnaires that during the period from September through June, about 25 per cent of the general practitioner's time in Iowa was occupied with cases coming under the heading of problems of otolaryngology. The incidence of ear, nose, and throat cases in the Air Force shows an even greater emphasis in this area.

Ear, nose and throat morbidity among aircrews originates from two sources: (1) Those conditions caused by the proximity of aircraft, and (2) those arising in the Air Force that are common to all armed forces and to all classifications of human society.

It is seen that it is the introduction of the aircraft itself into the environment that induces the additional stress causing the increase in ear, nose and throat problems. A physically capable airman must escape both hazards if he is to become a successful member of the Air Force community. These two hazards have their relative influence in reverse order: the causes of the greatest morbidity are those common to humanity in general; the conditions arising because of the airplane are fewer in number. But it is the airplane group that adds significantly to the total, and increases concern—for a disabled aircraft commander can readily place a large number of people in danger aloft. The effect of flight on the group of common conditions may magnify the disability a hundredfold, as well.

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The opinions expressed are those of the author and do not reflect the official views of the United States Air Force.

An analysis has been made of the Care of Flyer Report for the Far Eastern Air Forces during the year 1951, showing causes of grounding of flying personnel:

Total diagnoses:	6,042
Ear, nose, and throat diagnoses:	2,614
Per cent ENT diagnoses:	43%
Total days lost from flying:	49,004
ENT days lost from flying:	18,869
Per cent ENT days lost from flying:	38.5%
Mean days lost (all diseases):	8.11%
Mean days lost (ENT):	7.22%

With 43 per cent flyer problems coming into the province of the otolaryngologist, it is easily recognized that, service wide, there are plenty of the usual otolaryngological difficulties based on the numbers of cases alone.

Quite apart from his physician-patient relationship, the otolaryngologist plays another role in the Air Force that is the primary concern of the practitioner in aviation medicine. Along with its kindred specialty, ophthalmology, otolaryngology finds it is vitally concerned with the daily business of military aviation. Flying an aircraft as a weapon—at extremes of speeds and altitudes, using machine guns, rockets, and bombs that require a high degree of performance on the part of aviators is very different from a relatively slow, low-level commercial transport operation. The additional factors of combat and injury, cold temperature of the very high atmosphere, breathing oxygen through devices such as the pressure mask, living under fairly primitive conditions in the field, all go together to make medical concern for the military aviator a very great one.

There are other considerations that stimulate physicians in the Air Force to devote all available time and energy to the conservation of personnel—the manpower situation and money. This subject is one the Air Force medical officer cannot escape. Because the Air Force is committed to provide a much larger fighting force than it now has, with only about a ten per cent increase in personnel above the present level, every possible effort must be made to use each man to the limit of his capabilities. This is the mission assigned to the Medical Department of the Air Force—the reduction of the noneffective strength. Before World War II, the cost of training and educating a pilot was about $40,000. That figure has now risen to

$90,000 to $100,000. The $40,000 fighter pilot of 1940 flew a fighter plane worth about the same amount. Present planes cost from ten to twelve times as much.

A small part of these increases is due to the general inflation of the postwar period. The greater part is the price of increased effectiveness. To this end also the service must salvage every man possible.

Because of the medical-military manpower shortage, most otolaryngologists are required to do some teaching. Otolaryngology is so important that every flight surgeon must know a great deal about it. Many medical schools fail to give this subject the emphasis that it deserves. With the reduced number of doctors available to the military forces and a shortened period of service for each physician very certain, it is to be hoped that the department of otolaryngology in every civilian medical school will extend and amplify its teaching.

The phases of military aviation that present a challenge to otolaryngology are:

1. Communications and noise.
2. Special orientation and equilibration.
3. Atmospheric pressure changes.
4. Direct stress effects of high altitude.

These problems become obvious to anyone who visits an Air Force base or spends a day with the forces in the field. If the base is a fighter jet wing, there will be about a hundred tactical aircraft, plus a complement of personnel carriers and a few trainers present on the flight line. Work on preflight checking of the aircraft, fueling, arming, and radio checking begins about four o'clock in the morning. The pilots arrive about six, change into flying clothing, and go to the briefing room. After the briefing session, charts and maps are picked up, aircraft clearances are filed, and then they go to the ready room for the remaining flying gear. The first squadron climb into the aircraft, checks and starts engines, moves down the taxiway to the airstrip, and is soon airborne. As soon as the squadron is out of sight, one can move back into the operations office and keep in contact with the airplanes aloft by radio.

COMMUNICATIONS AND NOISE

By the time the whole combat group is aloft, the residual tinnitus will make the visitor easily appreciate the problems in noise and communication. Because of the distances and velocities involved in aviation today, radio has come to be very important. The origination

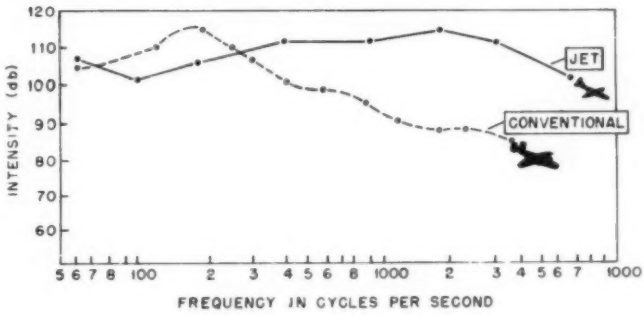

Fig. 1.—Aircraft noise spectra.

and reception of vocal signals requires excellent organs of hearing, normally functioning middle ears, and capable phonation.

By far the biggest current problem in aviation otology is the effects of noise and communication in noise.[2] Roughly five years of peace and three of combat operations have gone by since World War II. In this period the jet engine as a power source has reached astronomic proportion. A precise knowledge of the noise problem is required—damage to the hearing, methods of assessment of damage, and techniques of combating hazards arising around propeller and jet aircraft. Sound energy in the vicinity of many present-day conventional aircraft can and does reach intolerable levels. Sound derived from the conventional propeller driven reciprocating engine aircraft is noticeably different from that of jet aircraft (Figure 1). The conventional aircraft noise is a discontinuous "line-type" spectrum; its envelope curve is seen on the top. The jet produces a peculiar type of noise, called *white noise*, from the analogy to the mixed frequency spread of white light, whose spectrum is slightly lower than that of the conventional craft, but runs in a fairly flat plateau, particularly in the higher frequencies. The difference between the two noise types may be likened to the difference between a picket fence and a slightly lower solid board fence. Just as there is more lumber in the lower solid fence, so there is more energy available for damage to the ear in the white noise from the jet. Fortunately, the sealed cabins of the jets keep nearly all of the higher frequency sound from the cockpit, and the low frequency elements that remain do not carry the excessive peaks of the conventional noise. As a consequence, a jet cockpit is pleasantly quiet and most pilots are pleased at the ease with which radio conversation can be carried on.

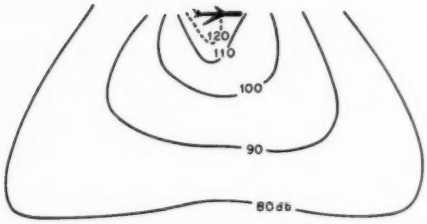

Fig. 2.—Sound fields around a B-47 Strato-Jet Bomber (modified from Sound Survey Report, Hq. S.A.C. Aug. 13, 1951).

The advent of the jet engine has taken primary attention away from the aircrew and has centered it on the men working on or near aircraft on the ground. It is these ground maintenance workers who face the greatest noise problem. Although spread of sound on the ground is subject to many varients of terrain and atmosphere, jet noise can cover a tremendous area (Fig. 2).

The figure shows one equal intensity measurement around a B-47 Strato-Jet Bomber on the ground. The 80 db level is over 2,000 feet and in the 90 db level is about 1200 feet from the airplane. The closer one gets to the airplane, the louder the sound becomes. It is almost unbearable directly under the aircraft wing. Possible consequences of the noise intensity to which men are exposed not only include damage to the organ of hearing and a variety of vague complaints of vertigo, irritability, lethargy, and nausea, but also maintenance error. The ground accident rate, which is always high in noisy environments, can also be expected to rise. It is known that noise levels as low as 90 db can affect auditory acuity. Sound intensities of about 120 db are definitely uncomfortable and those of 130-140 db are painful. Noise level tolerances have been established for different locations depending upon their use. Figure 3 shows such allowable curves. It is seen that intensity is the primary concern, but that frequency also plays a part, a much lower intensity level being allowed for the higher frequencies. In the vicinity of fighter planes on the ground, we find noise levels of about 110 to 140 db very common. Men working on jet aircraft engines almost always keep the engine running, in contrast to the practice of shutting off the conventional engine during maintenance. In some of the jet fighters, a mechanic must stick his head directly into the plenum chamber of the engine in order to make adjustments. The

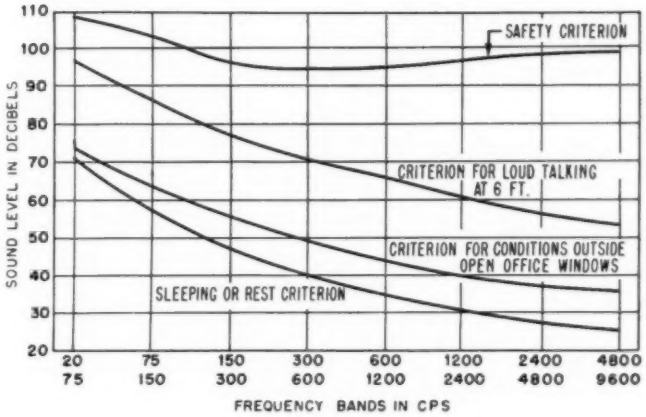

Fig. 3.—Noise level criteria (modified from Sound Survey Report, Hq., S.A.C. Aug. 13, 1951).

noise level is slightly under 130 db at idle power setting in this location and may go well above 140 db at 100 per cent power setting.

Regardless of the type of aircraft employed on a base, the constancy of operations is a significant factor in the evaluation of the noise hazard. On busy flight lines the noises from operating aircraft, auxiliary power units, and a variety of other power-driven tools and vehicles may combine to maintain the average ambient noise for all men in the area at a level well in excess of the 85-90 db safety level.

Quite severe depressions in hearing can be suffered without danger of permanent impairment, if sufficient time is allowed for recovery before the next exposure. If the time for recovery is insufficient, the losses become additive and ultimately permanent.

Prevention of damage from noise in men working in extremely noisy areas calls for a thorough indoctrination program. Without the cooperation of the individuals concerned, any such program would be highly ineffective. For example, most men know that ear plugs of the insert type will offer protection against noise, but commonly one sees men take ear plugs out in order to listen over the radio in noise. If it is explained that the ear defender reduces the total noise level and therefore increases the relative intensity of any radio signal that is received, then continuity of wearing will be greatly increased. It must also be emphasized repeatedly to the men that it is desirable to

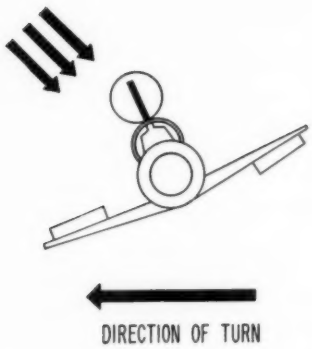

Fig. 4.—"G" forces acting upon a pilot in a skidding turn.

get as far away as possible from noise sources when it is not necessary to be near them.

Service laboratories are now developing many tests that may be of value to the Air Force and later perhaps to civilian otology. One of the most useful tests is noise audiometry to show hearing efficiency in noise.[3] Through this and other tests, we have salvaged deafened aviators in key or critical positions who require hearing aids for signal of low intensity on the ground, principally in office or in social situations, but who can be shown not to have any depression of noise tolerance levels and to have a useful auditory area by such speech reception tests in noise. In the air, these men wear no hearing aids and for signals presented over the radio at intensities required by the normal individual in order to be heard over the noisy background, they have no more handicap than do other members of the crew.

AERIAL EQUILIBRATION

Flying in a high speed jet fighter, the novice will find some rather confusing things taking place. For example, he will find that his sense of relative position in space is completely unreliable. In many turns he will be 90 degrees to the vertical and yet have no sense of being tilted at all. The translation of terrestrial equilibration into aerial equilibration is difficult. Probably flying is one of the greatest departures from normal terrestrial equilibration that the average man will ever undergo. This is because the physical contact is limited exclusively to the aircraft, the aircraft operates without reference to the direction of the force of gravity, and vision is re-

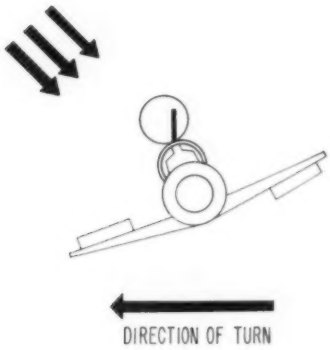

Fig. 5.—Effect of "G" forces on the human receptor mechanism in the skidding turn.

moved from customary close points of reference. In addition, there are a number of kinetic factors of flight: the accelerations are marked, the aircraft can rotate through various arcs and degrees at many rates, through different patterns, and centrifugal force profoundly modifies the forces of gravity.[4]

Equilibration on the ground is governed by the triad of vision, vestibulation, and proprioception. On the ground, equilibrium may be maintained by any two of these three components. In this respect aerial equilibration differs sharply from terrestrial equilibration. The one absolute essential sense which must be present at all times, aloft, is vision. Under so-called instrument conditions, all one does is to transfer his gaze from the windshield to the instrument panel and by means of the instruments develops a new sense of attitude.

Flying under all conditions of weather was early recognized as necessary if aviation was to take its place as an essential form of human transportation. Studies of the human factors under "blind" flying conditions outline certain well-defined phenomena. Successful use of mechanical aids to orientation and equilibration has followed identification and understanding of these phenomena, the so-called illusions of flying. The student aviator should learn these illusions early in his career. Disorientation aloft is based on the loss of adequate visual cues on the one hand and the presence of gravitational cues on the other. Gravitational cues will correctly orient

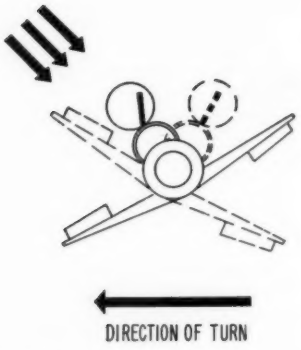

Fig. 6.—Illusion of opposite tilt in the skidding turn.

one to the aircraft and the cabin structures but not to the ground beneath. If the pilot, flying in a large cloud mass puts the aircraft into a skidding turn, he definitely experiences a false sensation. A skid in an airplane is no different from a skid in an automobile, as both leave the course to the outside of the turning path. In other words, the radius of curvature is increased during the turn. This means that there is an insufficient degree of bank, be it airplane or automobile, to compensate for the increase in g-forces acting upon the vehicle (Fig. 4). The arrows in the illustration indicate the resultants of forces acting upon the body. In the skidding turn, the resultants of forces do not act from head to seat, as would be the case in a coordinated turn, but press the body away from the center of turn. The sensory organ of equilibrium of the inner ear is indicated by the bar in the pilot's head (Fig. 5). The uncompensated forces will deflect the bar away from the direction of turn. This tilting of the hair cells will be interpreted as body tilt away from the center of turns. The pilot immediately refers his sense of tilt to the tilt of the aircraft since he still has the same relative position within the cockpit (Fig. 6). The danger in this situation is that the airplane is banked with the wing toward the center of the turn *down* but the pilot feels as though the wing is very *high*. In order to get rid of this sensation of turn, he feels as though he must bring the wing toward the center of turn *down* violently. This very often results in what is called an "over-the-top-spin" as the airplane rolls over to the inside and goes into a spin, often on its back, from which recovery is extremely difficult.

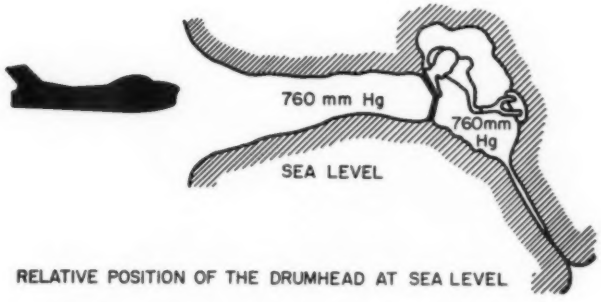

Fig. 7.—Diagram of the human ear as an air-containing structure.

Anyone engaged in any aerial acrobatics or experiencing much change in altitude, will be immediately impressed with the necessity for ventilating the middle ear. Imagine you are flying an F-86 Sabre Jet between 45-50,000 feet, and are in combat with a MIG-15 in North Korea. On one of his turns the MIG has a lucky shot and blasts a cannon shell through you canopy. In the fraction of a second your canopy has disappeared in the air behind you, taking with it the helmet, oxygen mask, headphones, and all other attachments on your head. You have also lost another important part of your equipment, the air within your cabin, and you are placed immediately in an extremely dangerous situation. At this altitude, without a pressurized cabin and pressure breathing equipment, you have a period of useful consciousness of about 15 seconds. After such a period at this altitude you would rapidly become unconscious and, because of the severe degree of hypoxia, would soon be dead. Aerial bends from nitrogen bubble formation would be a serious problem. As soon as you realize what has happened, forward goes the control stick and the throttle and you drop to lower safer levels as fast as you can.

Cases are on record of men who have brought airplanes down from such levels to altitudes of 7-10,000 feet in less than 30 seconds. This is roughly a rate of descent of about 90,000 feet a minute. In commercial aviation people often have trouble with their ears during descent. The rate of descent normally used is 200-250 feet per minute. Thus, under the military circumstances mentioned, descent would be from 180-450 times faster than the normal descent of a commercial aircraft. Without adequate indoctrination on the ventilative function of the eustachian tube and the middle ear, it is known that the individual would be in severe trouble.

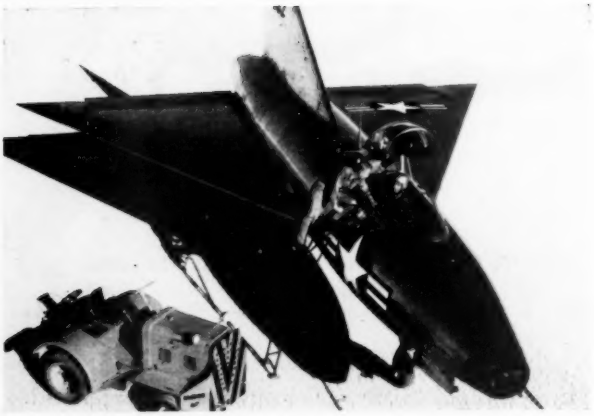

Fig. 8.—An experimental delta-wing fighter aircraft.

In the indocrination of non-otolaryngologists and flying personnel, it is explained that the eustachian tube acts as a valve that opens passively at equal intervals of altitude on ascent (Fig. 7). As the eustachian tube opens, clicks are heard. The first opening click occurs at about 500 feet and succeeding clicks about every 435 feet. On descent the tube remains closed unless actively opened. If the tube is not opened the following sequence of events quickly develops: A severe retraction of the tympanic membrane takes place; then the excessive negative pressure induces a transudation of fluid. Quite often an actual rupture of blood vessels in the layers of the tympanic membrane and in the lining of the middle ear cavity occurs. This rupture is severe enough in many cases to actually strip the membrane from the bone beneath. Hemorrhage of all degrees, from small petechiae to hemotympanum, are found.

Ignorance of the necessity of ventilation is probably the greatest cause of aerotitis. It is amazing to see how quickly fluid forms in the middle ear. If on free-fall descent from an altitude of 40,000 feet, blockage occurs at 20,000 feet, by the time ground level is reached, fluid may already be formed within the middle ear and pain has already reached acute proportions. It is felt that restoration to normal as quickly as possible is the best form of treatment. This is most easily done by shrinking and cleansing the nose and then removing the fluid by politzerization.

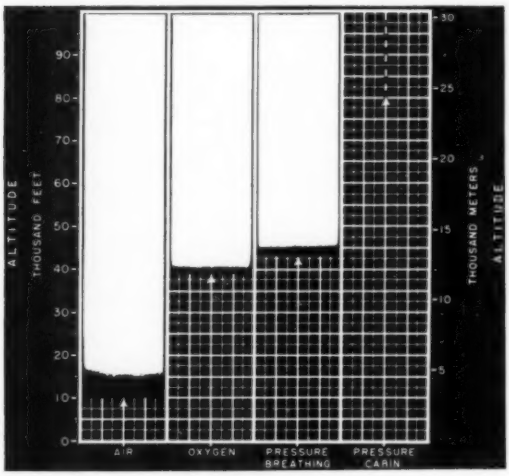

Fig. 9.—Human altitude ceilings with various types of equipment.

Figure 8 pictures one of the Air Force experimental delta wing fighters. One has only to sit in the small, cramped cockpit to realize what a tiny volume of space a human occupies. Because explosive decompression would quickly exhaust all the air, cabin pressurization levels are not permitted to the extent that flight at high altitudes without supplemental oxygen through a sealed mask can be accomplished. The temperature is very low at these extremely high altitudes; the oxygen that is carried is bone dry and free from all moisture. Besides at these altitudes, the air itself contains very little water vapor; consequently any air that is pressurized still contains practically no water vapor. Rhinologists are learning to appreciate fully the role that moisture plays in the protection of the upper air passages. Oxygen itself may well have some irritative qualities on mucous membranes particularly when applied in high concentrations under pressure. A number of the men who fly most of the time at high altitudes requiring the use of pressurized oxygen are beginning to exhibit the symptoms of progressively increasing hyperplastic rhinitis. This problem is being studied in order to devise means of increasing the humidity of inspired air and to reduce the demand upon the nose.

The fight for aerial supremacy in the past has been in large part a fight for an increase in altitude. Today's aircraft will far outper-

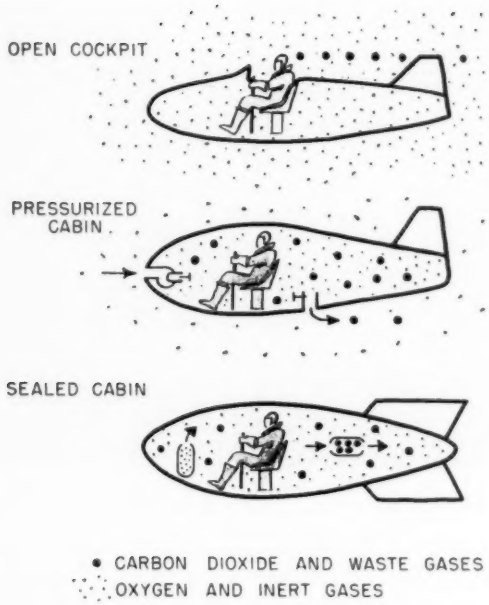

Fig. 10.—Diagrammatic representation of intake and exhaust gas relations in various types of aircraft cabins.

form man at today's ceilings. Figure 9 shows man's limitations. With no equipment, hypoxia begins at about 10,000 feet. By the use of 100 per cent oxygen, supplied on demand, the ceiling is raised to 38,000 feet. A small but significant increase to 43,000 feet can be made by the use of pressure-breathing equipment. Theoretically, the pressure sealed cabin has no limits. The relations of intake and exhaust of waste gases are seen in Figure 10: free interchange with ambient air at the top; pressurization turbine and bleed in the middle; self-contained gases and absorbers below. It is this last type of cabin that the Douglas Skyrocket, powered by rocket motor, contained when it set the altitude record of over 80,000 feet. It is because at these extremely high levels there is very little atmosphere to be compressed that a pressure cabin is out of the question for this or the higher levels of space travel. In both instances, the atmosphere must be with the flyer when he leaves the ground. The Medical Service must know well the requirements for a sealed cabin as far as moisture, oxygen tension, temperature, and waste gas tolerances, insofar as the

upper passages are involved, if it is to fulfill its mission and assist in maintaining a United States Air Force as a foremost power.

While this article outlines major problems in aviation otolaryngology, there is still much to be done. Because of the personnel and the physical limitations of the service, increasing demands are being made upon civilian physicians and institutions for aid in the solution of these problems.

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XI

THE PRIVATE PRACTICE OF AUDITORY REHABILITATION

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AND

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Deafness is a symptom, not a disease. It is a symptom which invades every aspect of the patient's life. Probably few other symptoms are so persistent, so frustrating, so overwhelming, so enduring, so isolating, and so unresponsive to therapy.

Deafness denies the existence of the sounds of life, instills fears of insecurity, inadequacy, incompetency, stupidity, and rejection. Normally hearing people are annoyed in conversing with the hard of hearing and the latter are angered and frustrated. It is a diagnosis feared by parents; hesitatingly made by physicians, particularly in infants; generally unacceptable to adults, who too often postpone obtaining competent medical help, or seek false prophets promising miracle cures.

How shall these patients be treated, and by whom? Certainly, today, only physicians are trained to cope with a symptom complex of such magnitude. Ancillary services of teachers of speech and lip-reading, audiometricians, audiologists, and psychologists are requisite for the care, education and reeducation of the acoustically handicapped. Each of these specialists contributes his share towards restitution and rehabilitation.

Much of the contemporary knowledge of hearing, of deafness and of corrective or rehabilitative techniques has been advanced by non-medical investigators. The American Hearing Society with its chapters, the Volta Bureau, the many hearing clinics, universities, schools for the deaf, private teachers, hearing aid companies, and other groups all testify to the efforts to which people will extend themselves particularly when they cannot find the help they need at the primary source of medical, otological care—the otologist. The responsibility for the diagnosis, treatment and rehabilitation of the

hard of hearing is primarily the otologist's, and this is a responsibility which he cannot evade but must assume in ever-increasing measure.

Wishart[1] stated that establishing a physical plant and auditory rehabilitation services require considerable financing. Our experience permits us the conclusion that this is no more costly than equipping the office of a roentgenologist, internist, ophthalmologist, urologist or dentist. Hill and Koons[2] write that otologists can start such an enterprise modestly and plan for future growth—but start! They describe their project initiated on "the proverbial shoe string." A clinical rehabilitation unit can be constructed and can operate functionally efficiently without the elaborate refinements often incorporated in large hospital centers. The objective of a rehabilitation unit designed for private practice is to serve the patient. Research, study, investigation here are subsidiaries which can follow in the wake of clinical work. The immediate patient is the prime consideration.

The rehabilitation team must be captained by the otologist; the staff requires guidance concerning specific or systemic pathology of the patient. Uncorrectable visual losses handicap lip-reading. Asthma, nasal allergies, cardiovascular disease and many others as well as psychological problems may coexist with the otic and auditory defects.

The Journal of the Americal Medical Association[3] in an editorial described audiology as one of the expanding areas of otology. Such disparate factors varying from transistors which may revolutionize all electrical communication as well as hearing aids, new techniques in teaching, new surgical and medical procedures to improve hearing, and preventative medical measures such as modifying or neutralizing Rh factor and the successful immunization against maternal rubeola indicate the limitlessness of this field of medical endeavor.

Discussing Hill's paper Lederer[4] emphasizes the necessity for otological leadership. Stevenson[5] remarked that it is "unnecessary to wait until you get magnificent buildings.—Start off with an otologist, someone who will fit hearing aids, and teach lip-reading, there are your minimum requirements—What we really need to do is to do something for the deaf." Audiology can develop as an extension of otology and as sub-specialty. Hard of hearing patients are aware of the problems of obtaining the authoritative and constructive help. They recognize the desirability of adequate functional examinations, unbiased hearing aid selection, and auditory reeducation.

Included herein is an outline of an auditory rehabilitation unit designed to meet the needs of office practice. One may start with a simple set-up, planning to add to it as new needs arise.

Meltzer[6] suggested that auditory rehabilitation programs be incorporated into "rehabilitation centers supported by private or public funds." We suggest an additional category represented by the combined efforts of otologists and audiologists who participate in the practice of clinical auditory rehabilitation. It is not suggested that every otolaryngologist establish in his own office a complete auditory rehabilitation service, but that those otologists who are primarily interested in the rehabilitation of the handicapped will develop, in cooperation with an audiologist, a well-organized plant and well-trained personnel.

Since hearing aids form an integral part of the rehabilitation they must be available to the otologist. Several makes are desirable for hearing aid selection when fitting a patient. The products of six manufacturers will generally suffice, allowing for variability and flexibility. Many manufacturers accepted by the American Medical Association will cooperate. These manufacturers, or their authorized representatives, will issue sample instruments to be used only in testing; a procedure which immobilizes a significant capital investment for them. It is mutually understood that there will not be any profit, or other form of recompense involved, to the physician.

It is our practice that only the otologists make the plastic insert impression of the auditory canal. We disapprove of lay technicians taking such impressions. The ear is the province of the physician. A technician has little knowledge of the variable anatomy and pathology of the ear, and he is ill-prepared to pack a meatus with cotton and impression compound, and effect their safe insertion and removal. Certain states have statutes restricting the taking of dental oral impressions to licensed dentists only. Similar statutes limiting the making of the meatal impressions can be enacted to confine this procedure to physicians.

This outline describes a single functioning rehabilitation unit, and allowances should be made to suit the needs of any particular office and to meet the demands placed upon it.

The audiologist should supervise construction and equipment. Frequently equipment already in use in the otologist's office can be utilized as a nucleus.

GENERAL SPECIFICATIONS

I. Staff
   - A. Otologist
     1. Consultant Medical Services
        - a. Patient's own medical advisors
        - b. Internist
        - c. Allergist
        - d. Roentgenologist
        - e. Ophthalmologist
        - f. Psychiatrist
        - g. Psychologist
        - h. Neurologist
        - i. Dentist
        - j. Laboratory
   - B. Audiologist
     1. Clinical Acoustics
        - a. Testing
        - b. Hearing Aid Fittings
     2. Auditory Training
     3. Equipment, planning and supervision of construction, maintenance, improvements
     4. Supervision of rehabilitation program
     5. Supervision of teaching staff
        - a. Speech teachers
        - b. Lip-reading teachers
     6. Responsible for hearing aids used in fittings
     7. Evaluate new testing techniques
     8. Supervision of research

II. Plant
   - A. Physical Plant
     1. Reception room
     2. Consultation rooms
     3. Ear, nose and throat examining rooms
     4. Testing room, sound treated, ambient noise level less than 30 db (re: 0.0002 dynes/cm 2)
     5. Testing equipment area
     6. Class rooms
     7. Clerical area
   - B. Equipment and Supplies (audiologic)
     1. Hearing Evaluation Unit

a. Master control panel, switches, meter, etc.
b. Pure tone audiometers
c. Masking unit
d. Tape recorder-reproducer
e. Disc record player
f. Power amplifier
g. Headphones, cushions, and headbands
h. Loudspeaker in infinite or brass reflex baffle
i. Disc and tape recordings of test material
j. Talk-back unit, including microphone, amplifier, headphones, and monitor loudspeaker
k. tuning forks

2. Psychogalvanic skin resistance unit
   a. Direct current amplifier
   b. Leads and electrodes
   c. Faradic inductorium
3. Auditory training unit
   a. Reproducer unit including microphone, record player, amplifier, loudspeaker, and headphone sets
   b. Special teaching disc recordings, noise makers, etc.
   c. Skulls, anatomic models, illustrations, etc.
   d. Interoffice telephone system with amplified telephone for practice
4. Speech
   a. Films for practice
   b. Hand mirrors, wall mirror, tongue blades
   c. Desk type hearing aid
5. Speech (lip) reading
   a. Films for practice
   b. Motion picture projector and screen
   c. Reproducer, (can be the same as for auditory training)
6. Hearing aid selection
   a. Representative hearing aids
   b. Extra batteries for fittings
   c. Universal and stock ear inserts
   d. Fixed, common baffle for mounting hearing aids during fittings
7. Calibration and repair equipment
   a. Vacuum tube voltmeter
   b. Soldering iron, tool kit, etc.

8. Ear insert equipment
    a. Impression material
    b. Dental engine, polishing stones, buffers for adjustments
9. Miscellaneous
    a. Blackboard and related supplies
    b. Toys, selected for testing as well as entertaining children

III. Investigation of the patient

A. History
B. ENT examination
C. Tests of equilibration, when indicated
D. Additional medical studies, when indicated
E. Tests of auditory function
    1. Pure tone threshold audiometry
        a. Air conduction
        b. Bone conduction
    2. Weber audiometry, when indicated
    3. Stenger audiometry, when indicated
    4. Recruitment audiometry, when indicated
        a. Binaural alternate loudness balance
        b. Monaural loudness contours
    5. Speech reception tests
        a. Phones
        b. Free field
    6. Speech discrimination tests
        a. Phones
        b. Free field
    7. Speech to noise ratio
    8. Galvanic skin response pure tone audiometry, when indicated
    9. Hearing aid selection
F. Impression made of auricle and meatus, model for permanent insert
G. Speech analysis
H. Staff consultation
I. Patient consultation
    1. Discussion of problem
    2. Recommendations
        a. Medical therapy
        b. Surgical therapy
        c. Rehabilitation

1. Hearing aid, written prescription
2. Auditory training
3. Speech (lip) reading
4. Speech correction
5. Program planning
    a. Length of program
    b. Time of lessons

J. Follow up services
1. Subsequent reexaminations and retesting
2. Subsequent hearing aid reevaluations
3. Studies of speech
4. Studies of speech reading proficiency

SUMMARY

Clinical auditory rehabilitation must be planned to meet the patient's needs. Hospitals, universities, schools, leagues, and private practice are all part of a system of proffering medical service. The private practice of otology and clinical auditory rehabilitation belongs to this system.

(Moe Bergman Ed. D. has been the consultant audiologist.)

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XII

THIRTY-FIVE YEARS OF ARMY OTOLARYNGOLOGY

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Otolaryngology as a specialty is relatively new. Physicians who sought instruction in this particular field at the turn of the century received it in brief preparatory courses of from six weeks to four months. In certain instances these courses allowed only the most superficial acquaintance with this specialty. Similar short courses were devised by English-speaking teachers abroad, notably in Vienna and Berlin, and many American physicians visited Europe for this graduate instruction to round out their courses and their professional reputations.

In the 20 years prior to World War I, considerable progress had been made in both undergraduate and graduate instruction in otolaryngology. Such outsanding pioneers as H. P. Mosher, of Harvard; C. G. Coakley, of Bellevue; George Fetterolf; George M. Coates, of Pennsylvania; S. H. Crowe, of Johns Hopkins; R. C. Lynch, of Tulane; H. W. Loeb, of St. Louis; George Shambaugh, Sr., of Chicago, and others were making great strides in elevating the quality of instruction in this specialty. Organized formal training, however, was difficult to obtain, and for the most part, universities and medical centers offered only short courses. On the whole, better trained specialists received their training and practical experience in an unorganized manner—either by reviewing their basic sciences, working in clinics, or by preceptor training.

Grave deficiencies in the training programs in otolaryngology become manifest early in the first World War. Lt. Colonel T. C. Lyster, United States Army, was delegated by Surgeon General Gorgas to enlist otolaryngologists in the Medical Corps. Among many innovations established by Colonel Lyster in the Army during World War I was a Division of Surgery of the Head which was independent of the Division of Surgery in all general hospitals, and which included ophthalmology, otolaryngology, brain surgery, and maxillofacial surgery. This, indeed, was an innovation and it placed surgical specialists dealing with the head, and particularly those in

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otolaryngology, in a position of independence and importance far beyond that attained in World War II.

Dr. H. P. Mosher of Boston headed the Division of Otolaryngology in the Office of the Surgeon General in World War I. There was no list of accredited specialists, such as we now have, to work by. A committee consisting of Dr. Mosher, Dr. Charles Richardson, and Dr. Burt H. Shurly made up a list from the recommendations of outstanding otolaryngologists and from their own personal knowledge. In addition, a school was set up at Fort Oglethorpe, Georgia, to train and further screen candidate specialists before assigning them to hospital positions. Dr. Thomas J. Harris was placed in charge of the school and attained an enviable record there as its director.

The limited ability and experience of many otolaryngologists sent to Fort Oglethorpe for rating soon became a cause for serious concern to both Dr. Mosher and the Office of the Surgeon General. More than 70 per cent of these so-called self-styled specialists—in most cases highly recommended by their communities—were rejected by the Army at this school. It was a serious indictment against the competence, training, and ability of the men in our profession at that time. The establishment of the Fort Oglethorpe school was, in my opinion, one of the great medical achievements of World War I. The knowledge which came out of that school had far-reaching effects, some of which are felt even today. I believe that the revelation of the educational inadequacy of the specialists sent to Oglethorpe was responsible, more than anything else, for the founding of the American Board of Otolaryngology in 1924.

In general, the development of this specialty in the Army followed a pattern of progress similar to that of civilian otolaryngology and was pioneered by such men as Goldswaithe, Schlanzer, Reynolds, and others.

Immediately after World War I, the Army received authority from the Congress to place a maximum of two per cent of its officer personnel in graduate courses of varying durations. A small number of medical officers thus received graduate training in otolaryngology.

I was first exposed to our specialty in 1919 as a young medical officer in Dr. Moure's clinic in Bordeaux, France. Later courses included one in tonsillectomy by the Sluder method, with Dr. Sluder in St. Louis, and a year of graduate instruction at the New York Postgraduate Hospital and the New York Eye and Ear Infirmary. Practice in surgery was limited in these various courses, especially in

major procedures. Later I attended the Jackson course in peroral endoscopy in Philadelphia. It was marvelous didactic instruction, yet at the end of the course we were warned that we had received only a formal introduction into this new field. No statement could have been truer. Many hours of study, plus gradual experience in clinical cases, were required to increase our skill in this as well as in other phases of our specialty.

Frontal sinus operations, not infrequent in Army hospitals, were usually performed by the Killian method or by Skillern's modification of this method. This operation was most often performed for the cure of chronic sinusitis but occasionally also for the acute condition. It often involved radical surgery, that is, removal of the whole outer wall of the sinus with resulting secondary deformity of the forehead. Convalescence was long, but the patient usually recovered.

A moderately large number of patients with atrophic rhinitis (ozena) were treated with ichthyol tampons in Army clinics at that time. Most often these cases were observed in anemic dependents of Army personnel, although some were also seen among military personnel.

No clinic was complete without a carefully selected collection of nasal oils for treatment of nasal conditions. These oils contained carefully balanced groups of aromatic oils. One or more of these were always used as a vapor spray after nasal shrinkage. The widespread use of this spray as a method of therapy, both in and out of the Army, inspired a neurologist, Dr. Church, to label otolaryngologists as the "Pss-Pss Specialists." One of these aromatic oils became associated with my own name in military practice. It was labelled "Streit's Iodine Nose Drops" and contained a small but sufficient amount of iodine to color the oil beautifully, and was very pleasing in its effect.

Practice by appointment was almost unknown. Many Army clinics saw 50 to 100 patients daily in addition to such surgery as was performed by the otolaryngologist. Herculean attempts were made to treat and cure colds, acute secondary sinus, and middle ear conditions. In numerous clinics the use of cocaine spray, ¼ per cent in normal saline solution, was used as a shrinkage medium. I recall a number of patients who secured great relief from this "wonderful" spray. With the advent of neosynephrine in the practice of otolaryngology in about 1932, the use of cocaine was discontinued, and in view of our present knowledge of possible cocaine addiction, it would be criminal for any otolaryngologist to use it today.

Allergy and its manifestations were unknown, and I do not recall ever hearing the word used in medicine until after 1928. Its essential relation to nasal polypi and to nasal pathology was not understood for a least ten years more.

Mastoidectomies were both a challenge to the otolaryngologist and the bane of his existence. Hospital clinics, in the so-called general hospitals of the Army, reported an average of 75 mastoidectomies per year for the ten-year period following World War I, and accompanying these were the inevitable complications of sinus thrombosis, brain abscess, and otitic meningitis. The tragic drama that was often a part of this picture needs no word painting. The mastoid operation itself—both simple and radical—with its various modifications reached a high degree of efficiency as specialists gained in knowledge and experience. Continual progress was also made in the early diagnosis and prevention of intracranial complications.

The picture of the military clinics in the post-World War I period would not be complete without mention of the presence of such acute throat infections as Ludwig's angina, retropharyngeal abscess, and peritonsillar abscess.

The panoramic view of the practice of otolaryngology for this period is sometimes referred to as the "good old days" which, I am sure, no ethical specialist would ever want to see again.

Advances in our specialty since that time, especially those connected with chemotherapy, have been truly wonderful for the patient who is, after all, our chief concern, and if the antibiotics have seemed to place a strain on our pocketbooks, they have also taken away strain from our coronary arteries. Few physicians who have dealt with a fatal ear or sinus complication would willingly return to those days before we had the use of these new wonder drugs.

WORLD WAR II

During World War II outstanding physicians, in and out of the service, seized upon conditions found only during war to study and determine the benefits and dangers of new techniques.

At the outbreak of World War II, a review of the otolaryngological manpower of the country seemed to indicate that there were enough specialists to serve both the Army and the civilians. Consequently, no special training programs were started. Otolaryngology was not given the recognition in World War II that it received in World War I under General Gorgas. The General Surgery Branch under General Rankin, was given responsibility for our specialty, and

he guided it through the war until 1944, at which time a consultant was appointed primarily to coordinate the activities of the Army's three Aural Rehabilitation Centers.

Despite this lack of recognition, otolaryngology made many notable contributions during World War II. The treatment of aero-otitis media and the radiation treatment of nasopharyngeal and eustachian tube lymphatic tissue, as recommended by Crowe, were significant.

For the prevention of acoustic trauma, the soft ear plugs of the Army came too late for proper field trials, but in many regiments acceptable protectors were developed.

Three centers for deafened service personnel were set up during the war. These centers processed 10,000 patients whose hearing was subnormal either before or during Army duty, and surprising progress was made in their rehabilitation, often within the space of four to eight weeks. Careful history of hearing, screening to select the psychological cases and malingerers, selection of and practice with hearing aids, auditory training, speech correction, and lip-reading instruction all entered into these courses. The goal was to overcome the handicap. Each had a staff of psychiatrists, psychologists, physicists and audiometricians, speech correctionists, and lip-reading teachers, plus a technical staff of physicians. These rehabilitation centers stand as models for the entire profession, and as such should be the pattern for similar centers in civilian life.

The Army, in cooperation with the Veterans Administration, has continued to operate one of these centers at Walter Reed Army Medical Center for the diagnosis and treatment of conditions in this field.

Many advances in teaching and testing techniques, together with newly designed equipment and better trained personnel, have served to shorten the patient's stay to three to five weeks. Ninety-eight per cent of the patients admitted to the Audiology and Speech Correction Center are now returned to duty. The fact that these patients are now more willingly accepted by previously skeptical commanding officers signifies a growing realization that rehabilitated men can and do fill a real need in the armed forces.

Much credit for the advance in surgical techniques in otology belongs to Dr. Julius Lempert. Following his published report in the Archives of Otolaryngology in July, 1938, dealing with 23 cases in which he had performed a fenestration of the external semicircular canal in a one-stage operation by an endaural approach, his particular

technique, with few individual variations, has been generally accepted by the profession, and although statistical reports on its success in restoring hearing vary considerably, it is undoubtedly true that 50 per cent or more of the patients obtain a 20 to 30 decibel increase in hearing. Several Army otolaryngologists have been trained by Dr. Lempert and are now performing this type of surgery.

POST-WORLD WAR II

In 1947 a general residency training program, including otolaryngology, was organized by the Office of the Army Surgeon General as a means of securing trained specialists for the Army. Courses, running for three years and including extensive work in the basic sciences, were established at Letterman, Brooke, Fitzsimmons, and Walter Reed Army hospitals. These courses have received recognition from the Board of Otolaryngology, and graduates are now leaving the training centers. At present the total number in training is 13.

Applicants today are not coming into the program in sufficient numbers to fill the minimum needs of the service, principally because of the reduction of surgery in this particular field as a result of the use of antibiotics. This situation poses a serious problem.

In addition to the antibiotics, certain other factors have resulted in a marked reduction of otolaryngologic surgery. Even before chemotherapy made its appearance, the discoveries of Proetz and others had begun to deflate the value of surgery in chronic suppuration of the nasal sinuses. This tendency was accelerated as we became aware of the great role played by allergy in the production of various types of nasal symptoms.

The development of chest surgery as a specialty has further restricted our field. The chest surgeon has found it necessary to include the bronchoscope among his diagnostic tools, and it is difficult to make a valid objection to this, since there can be little doubt that the chest surgeon should first see the pathologic lesions which he is later to remove.

Another factor which has reduced surgery for the otolaryngologist is the increasing custom of the "family physician" to take over a part of the minor surgery in our field, especially in rural areas and small towns. Dr. Dean M. Lierle, in a recent questionnaire to 574 general practitioners in Iowa, showed that ½ to 80 per cent or an average 22 per cent, of their work was in the field of otolaryngology. This, however, is not a problem in Army clinics where there is always a backlog of surgery.

All of these things have made some feel that otolaryngology is a dying branch of medicine. Those of our profession who take this view place far too much emphasis on a few surgical procedures which are no longer frequently performed, and far too little emphasis on the over-all development of otolaryngology. Our specialty, like many others, is in constant ferment and members must be ready at all times to adapt themselves to changing conditions.

However, these changing conditions present a very serious problem for the future of our specialty, both in and out of federal service. If men of high caliber are to continue to be attracted to otolaryngology, they must be assured of a livelihood and a stimulating field for progress in the diagnosis and treatment of conditions peculiar to the ear, nose, and throat. The solution, however, does not lie in placing a fence around procedures in our special field and denying the use of its implements to those on the outside. It is believed that this might better be accomplished by expanding rather than restricting the field of otolaryngologists. In other words, we must further diversify the crop.

The study of allergies should be compulsory instead of a voluntary part of residency training. This may be done, as it is in the Army, by cooperation with the Department of Allergy or by developing departments within teaching institutions where the subject might be taught by otolaryngologists. There are many sound reasons for this addition to training other than those related to the residency itself, since many forms of hyperesthetic and allergic rhinitis are not helped by conventional allergy therapy alone, but require special assistance from the otolaryngologist.

Plastic surgery, as it relates to the head and neck, opens a broad new vista for our specialists. Numerous otolaryngologists are already doing very creditable work in this field. This can be extended to procedures other than those involved in the nose and the ear and may expand to include the head and the neck. In Army residencies all plastic surgery of the ear, nose, and throat is performed in the Otolaryngology Section under the supervision of the plastic surgeon. Thus, during their training, residents in otolaryngology may become adept in this important work. It is believed to be perfectly logical for the ENT specialist to enter this branch of the profession, provided he has the ability and receives the proper training.

Tumor surgery is another field in which otolaryngologists might benefit from training. Fifty per cent or more of the tumors encountered in tumor clinics at medical centers, such as Walter Reed Army Medical Center, are of the head and neck. Many of these

have their origin in the mouth or nasopharynx, and it is entirely logical that the otolaryngologist should assume an increasing role in the diagnosis and surgery associated with these conditions. This can in no way be considered an invasion of the general surgical field, nor can the general surgeon question the capability of the otolaryngologist in this respect for he has always performed laryngectomies which indeed constitute major surgery.

Modern civilization has made the ear the most important of the special senses, yet one of the most neglected branches of otolaryngology is the one concerned with the treatment of hearing losses. The Army has been responsible for demonstrating just what can be done in this field and has led the way in opening up new and vast possibilities to the otolaryngologist.

The ever expanding field of otolaryngology should also include such procedures as the removal of thyroglossal duct cysts and the excision of the submaxillary gland. Here, too, the otolaryngologist is particularly trained in the field of radical neck dissection. Residents at Army training centers should and do receive gradually increasing responsibility and participation in minor and major surgery of the head and neck. In their final year they perform these operations with little or no actual supervision.

A certain overlapping of the specialties is inevitable, and narrow delineation cannot be made. Proper training and ability should determine, to a large extent, where a specialty begins and where it ends.

In the Army today the resident emerges from his training armed not only with a thorough knowledge of the routine phases of his own particular field, but also with the additional knowledge of plastic surgery including otoplasty and rhinoplasty. He excels in technique in peroral endoscopy, is familiar with maxillofacial surgery from work done in cooperation with the maxillofacial dental surgeon, and performs certain types of neck surgery. It is obvious, therefore, that our specialty, although in a state of ferment, is rapidly adapting itself to the changing conditions of the present time and is emerging as a stronger and even more attractive field for the young specialist both in and out of the Army.

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XIII

THE PSYCHIC EFFECT OF HOSPITALIZATION AND SURGICAL INTERVENTIONS ON CHILDREN

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I know very well that I am a perfect layman in the sciences dealing with the psyche, and only the fact that I have performed a great number of tonsillectomies on children and that I have controlled those children during a longer or shorter period, offered me the motive to deal with the subject indicated in the title.

The psychic dangers of tonsil operations upon children no small subject to be sure, because a good treatise about it should cover the whole psychology of the child, including the influences acting upon it, for instance the surroundings, changes in the surroundings, acute disagreeable happenings, etc. And in trying to simplify this matter as much as I can, I have to acknowledge the impossibility of any simplification. I can merely state that certain children appear hardly affected psychologically by this operation, whereas others undergo a most serious shock after the same treatment.

Can it be possible to find the cause of the seriousness of this psychic trauma? Let me try to expose my views based upon my personal experience.

In the very first place the influence of the operation itself. No, it is better to say in the very last place the influence of the operation as such. It always strikes me again of what small importance the operation itself appears to be, if we try to predict the psychical consequences of the whole situation. Whether this operation is performed without any anesthesia, with a slight narcosis, or under deep general anesthesia, appears to be of less importance than one might perhaps be inclined to presume. If the psychical preparation for the operation has been well cared for, an operation without any anesthesia does not necessarily cause any psychical trauma. Unfortunately the psychical preparation is not exclusively in the hands of the specialist treating the patient, of the hospital staff or of the family doctor, but

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above all in the hands of the parents. The experienced otolaryngologist is very often able to prophesy the future behaviour of the patient at the very moment the parents come with their child to him to obtain his opinion about treatment.

A prophesy as to whether the child will be strongly influenced psychically by the hospitalization, the operation and all the other smaller and bigger events which accompany them depends both upon the parents and the child. It is not at all impossible that two children of about the same age, born from the same parents, and living in the same household react in quite different ways. As regards the children I may perhaps confine myself to the mention of deafness; deafness which so very often is one of the indications for operations on the tonsils and which in itself makes children susceptible to all kinds of psychical influences, a fact of permanent importance to the children's psychiatrist who should realize this constantly.

The age of the child as well as his intellect are undoubtedly of great importance. If it appears to be possible to discuss quietly with the patient the whole operation together with all its accidental occurrences and if he lets himself be satisfied about its necessity, the chances are that no bad psychical after-effects shall result from the intervention and that the reaction may be steered into the right channels. But alas, how many children are educated in such a way that it is possible to reason with them? Those who had a so-called old-fashioned education have merely learned to listen and to obey, and those who are modernly brought up, have learned solely how to have it all their own way; they are hardly restrained in the free realization of their own egotistical inclinations. You may talk to them but it is hardly possible to have a conversation with either of the two types. Only those children who are brought up as future members of human society, who are taught what responsibility means, who learn to understand that it is impossible to be merely selfish without coming into conflict with others, who understand that disagreeable things may be absolutely necessary or at least desirable at times, who trust their surroundings, with these children and with these children only is it possible to have a conversation. And if these circumstances occur, for which good intellect and normal education are necessary, nobody needs to be afraid of any psychical trauma, provided the child has been told everything about what is going to happen: that he shall stay alone in the hospital without his parents; that he shall enter that imposing white room, the operation-theatre, that some gauze shall be put on his nose for the administration of the foul-smelling anesthetic or that he shall receive an injection for that purpose; he has to know about nurses and doctors in their white coats

and above all—a thing which is very often forgotten—he has to be told that his throat will hurt after the operation as soon as the effect of the anesthetic has ceased, that no narcosis can keep away his throat ache and also that some blood may come out of his nose or mouth. The blood very often gives strong panic reactions in unforewarned children. From my own experience I know children who endured everything—hospitalization, narcosis, operation—very quietly until they saw blood coming out of their mouth and reacted to this with the greatest dismay.

However, as I have stated before, the category of children with whom it is actually possible to talk is small and a large group remains which cannot possibly be prepared psychologically for the intervention.

How can we make the circumstances as favorable as possible to prevent the occurrence of more than the inevitable minimum of psychical shock? I put first and foremost that some psychical influence shall always be present but that this influence needs not necessarily be disastrous. On the contrary, the child learns to fit in with life, with its social surroundings by coming into collision with both of them; in this way it abrades its psychical skin but in this way too it gets civilized i.e. in this way it learns to find the right path through life and society. Let me give an example to illustrate this point.

Sometimes deaf children are admitted into a boarding school, whereas others are educated in a day school, remaining in the sphere of a normal household during the rest of the day. During the school period the former category feels uncommonly happy but after entering normal life they often feel lonely and abandoned. In the latter group, however, we often find a sense of melancholy on account of their invalidity, they feel neglected and unhappy. But on entering society they are better equipped and better adapted to the struggle for life; they are already accommodated. Whether you think a carefree youth to be of more importance than success in later life is, of course, a matter of taste.

I have always understood that in psychiatric circles complexes and inhibitions are looked at with abhorrence. It is very well possible that some people will draw the conclusion from my arguments that I do not object to the development of some complexes and inhibitions. So be it, a well-chosen group of both of them is not, in my opinion, a dishonour to any human being.

Anyhow, even if a psychical blow needs not in itself necessarily be a disaster—when the blow hits too strongly it may have disastrous

consequences. Precautionary measures are highly desirable, or rather, they are absolutely necessary. Nevertheless many children are still submitted to operation and hospitalization without any such precaution. The administration of some form of general anesthesia is altogether insufficient. Hereby the most important traumatic occurrences are left uninfluenced as, for example, abandonment by the parents, the strange gruesome atmosphere of the hospital, the state of tension on account of all the things never seen before, the fear of the operating theatre or the room of the anesthetist, the after-pain and the bleeding after the operation. General anesthesia may even entail a great danger e.g. the danger that some surgeons may think that they have done enough to reduce the operation to a trifle for the patient. This operation, which an expert otolaryngologist is able to perform in a few seconds, is and remains an important occurrence which, provided it is based on a well contemplated indication, may be very beneficial for body and soul, but which can also lead to serious psychical damage if the neecessary precautions are not taken.

It is an important intervention, which provides the possibility of changing a pitiful fragile little body into a sound creature, which may prevent earaches and protect the patient against deafness which —but no, I will not enumerate all the good results, you know them as well as I do. If it is at all possible, the child should be convinced of them before it is sent to the hospital. In the hospital too the child is entitled to be treated as a person who is up against something of importance and who should not be neglected as an accidental and an insignificant case. His questions should be answered as much as possible and as truthfully as corresponds with his mental capacity. He should not be taken by surprise; taken from his bed onto a stretcher and brought to the surgeon, who narcotizes him without any warning or shows him all kinds of ugly instruments. Quietly and calmly everything has to be prepared, especially the patient himself. But on the other hand his protests should be quietly but firmly rejected.

Experience teaches us that the well-educated, sensible child hardly protests at all and that the badly educated, less intelligent one quiets down under this treatment. If anesthesia is used, the operation takes place without the conscious presence of the child but then, to my opinion, the most important moment appears: the coming out of the anesthetic. At that moment every patient needs help and support and the person who is able to help and get a certain amount of hold over him, can be sure of his gratitude in the future.

In this respect I may speak from my own experience because my tonsils were removed when I was 14 years old and therefore in a period in which some conscious notion is possible as well as some analysis of unpleasant sensation. The tonsillectomy was performed without narcosis, but my parents had given me a good mental preparation. Everything appeared to be less terrible than I had expected with only one exception that is that after the operation I was left alone on a stretcher and, later on, in bed without any mental support. Notwithstanding all the good bodily care, this moment was one of terrifying loneliness and desolation. For this reason I always try to set the child's mind at ease, to say some kind words to it or to give it some water just at the moment at which it recovers consciousness. Moreover, the nurse in the ward is especially instructed to let these patients drink regularly as soon as they are awake after the operation. This has the great advantage not only of diminishing the number of postoperative complications—after-bleeding, fever and after-pain have become an exception—but above all of compelling the nurses to take good care of the children as they should induce them to drink. The only way to achieve this is a kind word, provided this is supported by the conviction of the necessity, a conviction which is transferred to the child. In my clinic a little trick is used for this purpose. The children are not given plain water or milk but a sourish red lemonade. If some of this fluid flows back into the glass, no change of colour takes place. The colouring of water or milk by the admixture of blood is often the cause of much distress and anxiety. The results of this uncomplicated treatment are such that I gladly advise every surgeon to put it into practice. It hardly ever happens that the children, returning a fortnight later to have their throats inspected, offer much resistance or even show many signs of anxiety. On the other hand I always avoid the sudden confrontation of the patients with our frightening instruments, both at the control as well as at the first visit. It is very remarkable indeed how many nervous and untractable children let themselves be examined when sitting in the lap of the examiner.

Finally a few words about the stay in the hospital. Without any doubt staying in a hospital is not the ideal condition. In my opinion this stay should be as short as possible. In the case of a tonsillectomy the danger of complications, especially of after-bleeding is over in about 24 hours. A longer sojourn should be avoided, I think, not only for the bodily but especially for the psychical health of the child.

Some surgeons are of the opinion that endotracheal narcosis is preferable to some form of twilight sleep with gas, chloraethyl or

some other similar substance. In this judgment, I am sure, esthetics play an important rôle. Dissection-tonsillectomy under deep endotracheal anaesthesia is indeed a prettier sight to the observer than the guillotine method of Sluder under a very light narcosis. But the advantages of the latter method, provided it is performed by skilled hands, are enormous. A very short intervention—for a trained surgeon about 30 seconds or less for two tonsils—a very slight narcosis, less after-pain, fewer complications (compare Anglosaxon with Continental literature on this subject) and a shorter stay in the hospital.

This is something out of the experience of an otolaryngologist, who has operated upon the tonsils of many little and older children, sometimes the success has been rather great, at other times I was disappointed, I need hardly tell you this. Nevertheless I think that the tonsillectomy, provided it is based on a good indication and provided it is surrounded by every possible care and precaution, is one of the most beneficial interventions, which modern medical science is able to perform. And this (oh, intricacy of everything dealing with the living!) not solely for the body but also for the psyche—for the operation may endanger the psychic equilibrium of the patients—who ever has seen, as I have, how dull mugs, stupid indolents, inert duds change as if by magic into active, alert, flourishing, intelligent rascals after only such an "unimportant operation," will understand the paramount importance of this intervention not solely for the body but also for the psyche. And I am sure they will agree with me that in the essence of psychosomatics the psyche is not always primary but often secondary to somatic circumstances and perhaps they will also understand that some people are opposed to the division of a human being into a body and a psyche, even if these two are later combined in psychosomatics. The true synthesis is not psychosomatics but anthropology, the knowledge of the one and undivided human being.

I am quite conscious of the fact that I have not given a review of the problem announced in the title. I have only tried to open up for you one aspect of the question, a highly specialized aspect, but on the other hand I am also sure that in the case of other operations or treatments, similar problems will occur; they will differ depending on the special case and the individual patient.

UNIVERSITEIT VAN AMSTERDAM.

XIV

THREE REPORTS ON THE CHEMICAL COMPOSITION OF THE FLUIDS OF THE LABYRINTH

I. DETERMINATION OF HYALURONIC ACID IN THE ENDOLYMPH

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As previously reported by the authors,[1] the endolymph of Acanthias vulgaris is a clear, highly viscous mass which does not mix with water or perilymph and which is liquefied by hyaluronidase.

In this report further results of the investigation are given, and as the finding of a high content of hyaluronic acid in the endolymph of the labyrinth may be of profound importance to future research work on this organ, the analytic procedures are given somewhat detailed.

Having seen that the endolymphatic substance is liquefied by a mere trace of hyaluronidase,[2] the natural consequence was to isolate the presumed hyaluronic acid and submit it to chemical analysis.

To verify the identity of the presumed hyaluronic acid, the following analyses would be required:

1. Determination of the solubility.
2. Determination of the relative viscosity.
3. Disaggregation by hyaluronidase.
4. Determination of the molecular weight.
5. Determination of the nitrogen content.
6. Determination of the potassium content, as the hyaluronic acid was isolated as its potassium salt.

These analyses would require about 40 mg of the isolated hyaluronic acid and consequently a large amount of labyrinths had to

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be emptied. More than 300 labyrinths were employed for this purpose alone. None of the animals had been dead for more than 40 hours and they were stored and mailed on ice. Great care was taken to avoid admixture of blood, as it is known that ferrous-ferric-ions will depolymerize hyaluronic acid.[3]

The authors have developed a special technique which makes it possible to do this quickly and yet be safe-guarded against contamination with blood or mixture of peri- and endolymph. (See Part II.) For further details concerning the anatomical details in question, the reader is referred to a monograph by one of us.[1]

Altogether 44 ml of endolymph was employed. Just after withdrawal it was cooled to -1° C. and the isolation of hyaluronic acid was started immediately. The mucin of the endolymph was precipitated with one per cent glacial acetic acid. Preliminary dilution with water, as is customary in the procedure of isolation of hyaluronic acid from animal fluids, was impossible as the endolymph does not mix with water. Under the action of glacial acetic acid a mucin clot is formed. This clot was washed quickly but thoroughly with distilled water and submitted to treatment with four volumes of glacial acetic acid for 4 days. By this treatment the proteins attached to the hyaluronic acid are split off and such iron as may be present is absorbed into the glacial acetic acid. After this the part of the clot still present will contain the presumed hyaluronic acid. The glacial acetic acid was now removed by filtering through a Buchner funnel and washed with water.

By this treatment the bulk of glacial acetic acid was removed and the rest was neutralized to pH 7 by addition of saturated potassium hydroxide. After extraction with water, the presumed hyaluronic acid was precipitated as a stringy mass with four volumes of absolute alcohol.

The precipitate was now purified by washing several times with absolute alcohol and ether, distilled over sodium; and then it was dried to constant weight *in vacuo* over phosphorus pentoxide.

The 44 ml of endolymph yielded 32 mg of the substance believed to be pure potassium hyaluronate (73 mg%).

The mass which now had to be investigated appeared as a pearl-white, amorphous substance which was very hygroscopic.

The above-mentioned analyses to identify the substance chemically were now performed.

Determination of solubility. Hyaluronic acid, as related to carbohydrates, is known to be soluble in water but insoluble in liquids

dissolving fats, and our preparation behaved in this way as hyaluronic acid. We succeeded in preparing a one per cent aqueous solution of the substance. The solution was highly viscous and quite clear and it needed no centrifugation for the following determination of the relative viscosity.

Determination of the relative viscosity. The relative viscosity is defined as $\eta \text{ rel} = \frac{{}^{t}H}{{}^{t}W}$; where ${}^{t}H$ equals flow time of hyaluronate solution, and ${}^{t}W$ equals flow time of distilled water. The relative viscosity was determined by the Dalsgaard-Mikkelsen and Kvorning viscosimeter,[5] a modification of the classical Oswald viscosimeter. This apparatus has a capacity of 0.5 ml, the volume between the two marks being 0.2 ml. The flow time of our apparatus was 43.0 seconds at 20° C. for distilled water. Our temperature was constantly 20° C., the variations being only 0.01° C. On account of its hygroscopic character the substance was weighed in a stoppered weighing bottle.

We found the relative viscosity to be 24.24.

Disaggregation by hyaluronidase. As hyaluronidase is known to be highly specific towards hyaluronic acid (Chain,[6] McLean,[7] Robertson[8]) we tried, and succeeded in, disaggregating our substance under the influence of hyaluronidase. When hyaluronic acid is disaggregated (hydrolysed) by hyaluronidase, its viscosity is lowered.

Our experiment was performed in the following way:

Three ml of the above mentioned 1% aqueous solution of potassium hyaluronate was incubated with about 1 mg of hyaluronidase at 20° C. (variation: 0.01° C.). The viscosity of the solution which prior to the addition of enzyme was 24.24 (which is a remarkably high viscosity as the majority of figures reported in the literature concerning hyaluronic acid lie between 4-8) now decreased considerably in the course of one hour. Further addition of enzyme lowered the viscosity to about that of water in the course of 12 hours.

Determination of molecular weight. The amount of material available naturally restricted the quantity of our substance at disposal for this investigation to 10 mg. Fortunately this amount was quite sufficient for a determination of the molecular weight based upon osmometric measurements according to the method of Christiansen and Jensen.[9] This micro-osmometer has a capacity of only 0.5 ml. A detailed description of this is beyond the scope of this paper, but a few words on the principle of this apparatus may be appropriate:

A vertically placed glass capillary, the upper end of which is covered with a semipermeable test-tube-shaped membrane, and the other end of which is open, is completely immersed in a fluid (the "outer fluid"). In the glass capillary and in the membrane is the hyaluronic acid solution with a bubble of air in the middle of the glass capillary. The bouyancy will tend to move the bubble upwards, while the influx of the outer fluid through the semipermeable membrane at the top of the glass capillary will tend to move the bubble downwards. By varying the pressure artificially in the outer chamber, we are able to vary the length of the bubble. If the osmotic pressure of the inner fluid is larger than the bouyancy of the bubble, then the bubble will move downwards as the outer fluid passing the membrane moves into the tube.

If now we reduce (artificially) the pressure in the outer chamber, we will increase the length of the bubble and thus its buoyancy will increase even to the point where it will move upwards again.

The length of the bubble will, in the state of equilibrium, express the osmotic pressure of the inner solution. This length may be read graphically.

From the osmotic measurements, the molecular weight (M) may be calculated from the following equation:

$M=\frac{qw}{l}$ where w is the amount of substance in grams dissolved in 1 ml, l is the equilibrium length of the air bubble in cm, and q equals $\frac{RT}{gd}$, where R is the gas constant, T the absolute temperature, d is the density and g is the acceleration of gravity (981.6 cm/sec^2).

Based on the above we found the molecular weight of the substance investigated to be: 779×10^3.

This figure indicates that the substance very well may be hyaluronic acid (cf. the figures given by Christiansen and Jensen on hyaluronic acid from different sources of material[9]).

The apparent proportionality between viscosity and molecular weight exhibited by these above-mentioned figures is also seen here where both the viscosity and the molecular weight of our substance show high figures.

DETERMINATION OF THE NITROGEN CONTENT

The nitrogen content of our preparation was determined according to Kjeldahl (modified by Blom[10]) performed as a micro-analysis.

8-10 mg of the substance was employed for the purpose. We found the nitrogen content to be 3.33%.

The theoretical value calculated from the formula for potassium hyaluronate $(C_{14}H_{20}NO_{11}K)_n$ is 3.36%.

Determination of potassium. The potassium, determined as potassium sulphate, was 9.01%.

The theoretical value of the potassium content calculated from the above formula for potassium hyaluronate is 9.37%.

COMMENT

The above analytical results show with a certainty beyond all reasonable doubt, that the endolymph of Acanthias vulgaris contains large amounts of hyaluronic acid.

The content is found to be 73 mg% and this figure is considerably higher than the figures for nearly all other fluids investigated (including human synovia as found by Jensen in another connection).

The physical appearance of the endolymph in sharks and rays is essentially the same as the appearance of endolymph in bonefish (e.g. cod, which has been investigated by Vilstrup with reference to this point). The appearance of the endolymph in birds is said to be the same[11] and its appearance in mammals is again the same so far as we know (e.g. guinea-pig as seen by Vilstrup). In no animal investigated with regard to the physical character of the endolymph has the character of this substance been described as deviating from the description given here.

For quantitative reasons, the endolymph of the human ear is yet insufficiently investigated, but in view of the remarkably constant appearance (and probably also function) of the labyrinth within the whole vertebrate phylum, it is reasonable to assume that the findings given above for Elasmobranchii will reflect the conditions in the labyrinths of the higher vertebrates also.

In a forthcoming publication the significance of the findings reported in this paper together with the results of some other investigations on the chemistry of the endolymph will be discussed.

SUMMARY

It is demonstrated that the endolymph of Acanthias vulgaris contains 73 mg-per cent of hyaluronic acid. This is a higher con-

tent of hyaluronic acid than found in most other body fluids examined.

The nature of the presumed hyaluronic acid was determined by analyses for the various chemical characteristics known for this substance.

The results of these different analyses were in agreement with the well known characteristics of this acid, only the relative viscosity was higher than usually reported for hyaluronic acid. There is reason to believe that the results found for Acanthias in the main will reflect what will be found in higher vertebrates.

II. DETERMINATION OF THE TOTAL PROTEIN IN THE ENDOLYMPH AND PERILYMPH OF THE EAR-LABYRINTH

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The endolymph is a highly viscous, clear and pellucid substance of practically unknown chemical composition. Until now only very small quantities of this substance have been collected and thus only a few analyses (for inorganic ions) have been made (Perlman, Goldinger and Cales,[12] Dodds[13]).

In order to collect as large amounts of the substance as possible, labyrinths of Elasmobranchii were employed as these are the largest vertebrate labyrinths known and especially those with the largest membranous sacs.

As reported above (Part I) it is likely that the consistency of the endolymph in these animals is due to a large content of hyaluronic acid. This acid is attached to proteins, the quantity and nature of which are also unknown.

As knowledge of the protein content is essential to our understanding of the physico-chemical behaviour of the endolymph, we have submitted this substance to analysis with regard to these proteins.

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Technique. A short description of the technique for the collection of fluid may be useful in order to give evidence of the degree of safety which the operation yields against contamination with blood and perilymph.

The animals (Acanthias vulgaris) were mailed on ice (from Hirtshals to Copenhagen). They had been dead for 24-40 hours at the time they arrived at the laboratory where they were immediately operated upon.

The sharks were decaptitated by means of a vertical section in the binaural plane 3 mm behind the spiraculae. This section opens the posterior and lateral semicircular canals and passes just behind the sacculus. There was no outflow of endolymph from the membranous canals as these collapsed the moment they were cut with the knife.

Perilymph was now aspirated from the broad perilymphatic space of the lateral semicircular canal. Through this, it was possible to empty the whole perilymphatic space of the labyrinth almost entirely (as could be seen through the thin layer of hyaline cartilage covering the perisaccular space. This space was filled with air during the aspiration).

Each labyrinth yielded 0.2-0.6 ml of perilymph which was collected for analysis.

After this, a new section was performed through the cartilaginous skull of the animal 2 mm rostrally (anteriorly) to the first one. This latter section opened the sacculi broadly by cutting the tapering caudal ends of the sacs. The contents of these, the endolymph, is so viscous, that it does not flow out immediately by itself. It was aspirated by means of a glass tube with an inner diameter of about 2 mm. Each sacculus yielded from 0.1 up to (in the best cases) 0.5 ml endolymph—averaging 0.2 ml.

The Endolymph. The aspirated endolymph looks quite like the substance of the vitreous body of the eye. It is a homogeneous, viscous and completely transparent substance of high coherence. It does not mix with perilymph, blood or water even despite vigorous mechanical stirring. The endolymph from the different sacculi merges into a homogeneous mass in the test tube (which beforehand was placed in ice water to counteract autolysis and depolymerization of the contents).

For the quantitative analysis of proteins, the material was divided in two portions.

TABLE I.--THE PROTEIN CONTENT OF ENDOLYMPH AND PERILYMPH.

FLUID	PRECIPITATING AGENT	% PROTEIN	% N.
Endolymph	CCl_3COOH	1.8	10.58^x, 10.53^z
Perilymph	CCl_3COOH	1.2	13.35^x, 13.27^z

x: determined after Dumas. z: determined after Kjeldahl.

The first portion was submitted to the action of a few granules of hyaluronidase and was completely liquefied within 75 hours at room temperature.

The liquefied material was precipitated with one volume of 15% trichloroacetic acid at room temperature. The precipitate was extracted several times with ether. After this, it was dried *in vacuo* over silica gel and phosphorus pentoxide to constant weight.

The second portion was not submitted to the action of hyaluronidase but was otherwise treated in the same way.

In order to verify the protein nature of the precipitate, it was necessary to determine the nitrogen content. This was done by the method of Kjeldahl and besides, the nitrogen content was determined by the method of Dumas. The results were concordant and affirmative (Table I).

The precipitate gave the ordinary reactions for protein e.g. the biuret test, the test for sulphur and Millon's test.

The Perilymph. The perilymph *in situ* is in Acanthias a watery fluid, but after withdrawal it may be seen to clot. In many bonefishes (e.g. cod) the perilymph is gelatinous.[14]

In most cases, the semicircular canals, when opened, were quite free of blood extravascularly, but it happened a few times that a semicircular canal was filled with a clot of blood (agonal bleeding?). Such specimens were discarded.

The perilymph was centrifuged and afterwards inspected with regard to blood. Such samples as were seen to contain even the smallest amounts of blood after this were also discarded.

The following determination of total protein in the perilymph was performed in the same way as described above for Portion Two of the endolymph.

The results were concordant as seen from Table 1.

SUMMARY

The endolymph of the labyrinth of Acanthias vulgaris was proved to contain 1.8% protein, and the perilymph of the same animal 1.2% protein.

The analyses were performed according to Kjeldahl and according to Dumas.

III. FRACTIONATION OF THE PROTEINS OF THE LARYRINTH FLUIDS AND OF THE VITREOUS BODY

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In the present paper the results of a study of above proteins (Part II) are described as we submitted our material to investigation by means of paper-electrophoresis.

The principle of the method is this:

If proteins (which are amphoteric) are placed in an electricial field at pH 8.6 a separation will take place. The albumin will move faster than the globulins and thus the two fractions will be separated and the same holds true for single components of the globulin group.

The technique followed closely the lines given by Köiw et al.,[15] and only a brief outline of this will be given here.

From the Laboratory of the Finsen Institute, and the Institute of Physical Chemistry, Copenhagen.

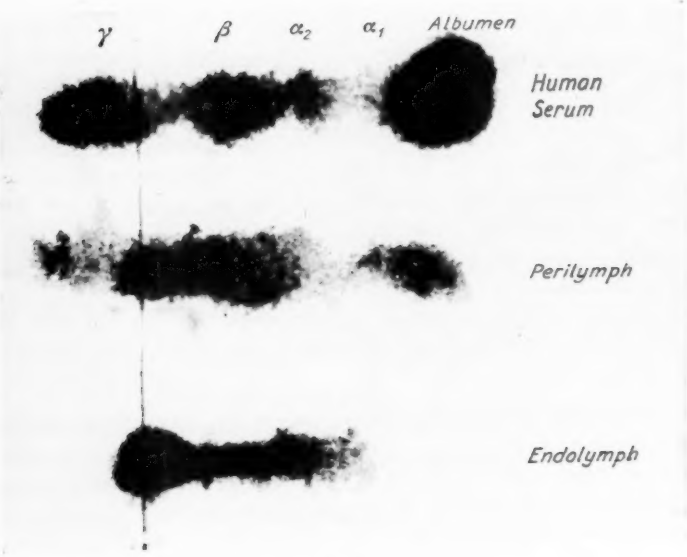
γ
β
α2
α1
Albumen
Human Serum
Perilymph
Endolymph

Fig. 1.

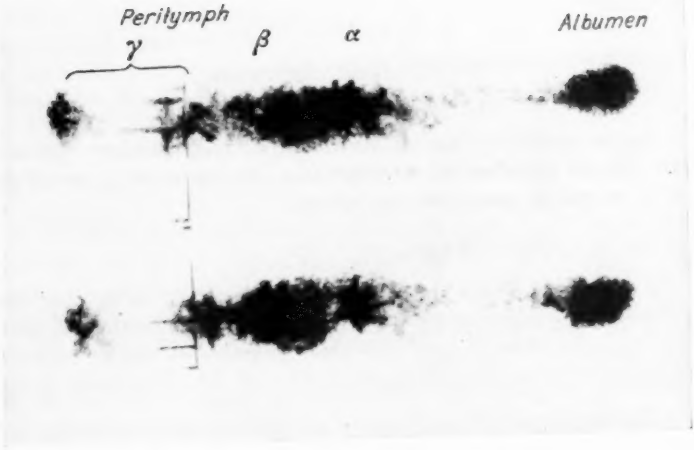
Perilymph
γ
β
α
Albumen

Fig. 2.

Fig. 3.

The drop of material which is to be investigated (0.025 ml) is placed on a filter paper (Whatman no. 3) buffered at pH 8.6.

The strip of filter paper is placed in a closed chamber and fixed by means of taut perlon threads. Both ends are placed in tanks containing the electrodes submerged in barbituric buffer solution (ionic strength 0.05). At the selected pH all protein particles present will be negatively charged and will consequently move towards the anode (potential: 3V/cm).

After 24 hours the material will be separated and spread on the filter paper where it can be visualized and measured.

The protein has a specific affinity for special staining materials (brom-phenol blue). The intensity of the staining together with the area covered by the stained spot is used for exact estimation of the relative ratios of protein components in the sample examined.

After drying, the filter paper was cut crosswise into sections (about 5 mm broad), and the dye was drained from each strip in a 5% solution of Na_2CO_3 in 50% methanol for one hour. The intensity of the color was read in a Bechman colorimeter (wave length 595 μ) and plotted in a coordinate system with the extinction co-595 μ) and plotted in a coordinate system, which is not shown here.

Results. The results of the electrophoresis are given in the figures.

In Figure 1 we have the diagram for normal human serum which is used as a reference. Below this the electrophorogram of

perilymph is given. From this, and especially from the lowest diagram in Figure 2, it is apparent that the perilymph contains albumin and globulins. The lowest diagram in Figure 1 clearly shows that the endolymph contains globulins but no albumin.

The striking difference between the composition of proteins in the perilymph and the endolymph is made clear in these electrophorograms.

Owing to the close resemblance between the apparent physical characters of endolymph and the substance of the corpus vitreum we found it interesting to submit the latter to the same procedure under the same conditions. The results are shown in Figure 3. The electrophorogram here was made on human vitreous substance. It is seen that the composition of proteins in the human vitreous resembles that in the human serum—and also that of Elasmobranch perilymph—but differs considerably from that of Elasmobranch, endolymph despite the apparent similarity. The albumin-globulin ratio was:

for human serum: albumin 79% and globulin: 21%.
(determined by us.)

for Elasmobranch endolymph: albumin: 0%; globulin 100%.

for Elasmobranch perilymph: albumin: 21%; globulin: 79%.

for human vitreous body: albumin: 43%; globulin: 57%.

All experiments were carried out in duplicate and the results were concordant.

The relative amounts of alpha, beta and gamma globulins in endolymph were calculated at 10.5 (12 and 9), 23.5 (21 and 26), 66.0 (65 and 67) respectively

The relative amounts of globulins in perilymph were calculated at: 7.5 (8 and 7), 26.0 (23 and 29), 46.0 (50 and 42) respectively.

The electrophorogram of corpus vitreum did not allow of a sufficiently sharp distinction between the globulin components for numerical calculation.

SUMMARY

Elasmobranch perilymph and endolymph and human vitreous substance were investigated by means of electrophoresis on paper and

the electrophorograms and the resulting curves given. The albumin-globulin ratios and the relative ratios of the globulin fractions are given.

AMAGERBROGADE 2.

We are gratefully indebted to Professor T. A. Christiansen, Chief of the University Institute of Physical Chemistry, Copenhagen for valuable assistance.

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XV

FOLDS AROUND THE TUBAL ORIFICE IN 622 VISUALLY CONTROLLED ADENOIDECTOMIES

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One of the most common causes of conduction deafness is obstruction of the eustachian tube by abnormal hypertrophy of neighboring structures. The visually controlled adenoidectomy awakened interest in the folds around the tubal ostium. Because of their strategically important position, any enlargement of these plicae may interfere with the free movement of the air between nose rhinopharynx and middle ear. Three folds are found there: the plica salpingopalatina, the plica salpingonasalis and the plica salpingopharyngea.

This presentation covers 622 visually controlled adenoidectomies and analysis of the salient anatomical, histological and pathological facts concerning the folds and their immediate surroundings.

THE ANTERIOR LIP OF THE TUBAL OSTIUM

For simplicity in description, the tubal ostium will be considered as having an anterior and posterior lip. The upper part of the anterior lip is formed by the lateral wall or hook of the cartilage; the pharyngeal end of the membranous tube constitutes the rest of it. It contains many glands and lies on a pillow of fat. The anterior lip of the tubal ostium is always accentuated by a strong fold of mucosa, the salpingopalatine fold. This is reinforced by a ligament which is a continuation of the membranous tube into the soft palate.

It was named by Tourtual the anterior salpingopalatine ligament. The appearance of this plica depends upon variations in the strength of this underlying ligament and the thickness of the mucosa covering it. The plica may be thin and transparent if the layers of glands and lymph follicles are thin, or it may be thick and very prominent.

At operation we concentrated our attention on the folds, measured and weighed the removed pieces, and examined them histologically.

The salpingopalatine fold can be located without difficulty, if one applies the edge of the Senturia or Love retractor to the free end of the palate, just lateral to the uvula. If one pushes the instrument too far backward, this salpingopalatine fold will be overridden and hidden, because the greatest part of its course lies on the posterior surface of the soft palate.

In our experience, the fold was always demonstrable. After arising from the anterior lip of the ostium, it forms a curve with the concavity facing the tube. In most cases it ends on the posterior surface of the palatopharyngeal arch.

Besides this fold which is directed downwards, there is another very important fold which arises from the upper part of the ostium and is directed upward towards the roof of the choana. This fold was named by Hoffman, the salpingonasal fold. Its thickness is variable. Under the mucosa of the salpingonasal fold a process of basilar fibrocartilage can be found; the fibres of this often unite with the anterior palatine ligament.

This is the reason that the salpingopalatine and salpingonasal folds often form a continuous plica instead of two separate ones. "Boundary Folds" (Grenz Falten) is the name given to these two folds.

In 138 or, 22.1%, of the 622 cases the width of the salpingopalatine fold adjacent to the tubal orifice was between 5 and 8 mm. Such a large fold on the anterior wall of the tube hangs down like a soft curtain and may cover the ipsilateral tubal opening, if the child lies on his back, or on his side.

In 45 or 7% of the 622 cases, the folds were wider than 9 mm, in some patients wider than one-half inch. Such a large mass of tissue in a child's epipharynx may obstruct it completely.

Tourtual described still another plica, located in front of the salpingonasal and salpingopalatine folds; this he called the lateral nasal fold. The sulcus separating this from the other two folds is called the posterior nasal sulcus.

After the removal of the adenoids, routine inspection with a mirror, demonstrated several cases where the salpingopalatine and salpingonasal folds were duplicated. One could not always decide, whether the fold in front is actually this lateral nasal fold or just a chance reduplication of the salpingopalatine fold.

In several cases, the salpingopalatine fold was between 5 and 8 mm broad, but barely covered part of the palatine velum and jutted into the rhinopharynx only 1 to 2 mm. In five cases, the salpingo-

palatine fold, although running most of its course on the posterior surface of the palate ended on the lateral wall of the pharynx.

THE POSTERIOR LIP OF THE OSTIUM

The mucosal aspect of the posterior lip is mostly rugged, slightly nodular. This nodularity is caused by the stomata of the numerous glands. This appearance can only be demonstrated after the covering layer of mucus has been removed. However, at times the torus may be edematous, swollen and smooth. The cartilage of the torus is 4-5 mm thick. This thickness may be increased by the covering soft tissues to 10 mm or more.

The plica salpingopharyngea arises from the posterior lip, continues downward on the lateral wall of the nasopharynx and oropharynx, behind the palatopharyngeal arch. It is usually 4-5 mm thick and is short. At other times, it is enlarged to more than 10 mm in width and 6-7 cm in length.

The tubal cartilage in a child is much shorter than in an adult. The downward growth of the medial portion is much smaller. The difference in thickness of the upper and lower portion is much less than in the older age group. In adults, the membranous portion is one third of the whole tube; in a child, it forms more than half. The midpoint of the ostium in a new born is at the level of the hard palate. Hence the salpingonasal fold is relatively longer than in adults. The ostium is situated so low that it is concealed by the soft palate; the concavity of which is much shallower in children than in adults. It is rarely observable during operation. The torus is small; the thin, small cartilage is unable to keep the opening of the tube ajar. So that in most cases, the tubal orifice is a thin curved cleft with concavity downward.

Histologically, the folds are quite similar to the pharyngeal tonsil at its inferior border. Usually the major portion of the plica consists of lymphoid aggregates occupying the tunica propria. Subjacent to this, are variable numbers of seromucinous glands, separated from the lymphoid tissue by a thin fibroelastic membrane. There is variation in surface epithelium, some of the specimens bearing squamous epithelium, others being covered by ciliated columnar cells. Epithelial infoldings, which on serial section are seen to be continuous with the gland ducts, give an uneven, slightly nodular appearance to the surface of the folds.

THE ROSENMULLER FOSSA OR PHARYNGEAL RECESS

The Rosenmüller fossa is an evagination of the lateral wall of the rhinopharynx, which lies behind the eustachian tube. In adults,

it is divided into two parts. The upper portion is that part of the fossa which lies above the level of the eustachian tube. It is called the superior sinus. The lower part is named the sinus lateralis They are demarcated by a small fold. In a child, the superior sinus is not present. The rest of the Rosenmüller fossa is broad, because the anterior-posterior diameter of the lateral wall is relatively large and the torus is small.

The wall of the pharyngeal recess consists of mucosa and fascia. The lateral side of the fossa is strengthened by the lateral pharyngeal ligament and is in contact with the parapharyngeal space. The top of the fossa extends to the basilar fibrocartilage.

The anterior wall of the recess is in contact with the medial plate of the tubal cartilage, the levator veli and a small part of the internal pterygoid muscle. The flexors of the neck and head are located behind its posterior wall. The lower border is often accentuated by the concave edge of the superior pharyngeal muscle.

If the torus is very thick, the width of the fossa diminishes. If, in addition the posterior wall of the pharynx is pressed forward by the longus capitis muscle, the fossa may be reduced to a mere cleft. The mucosa normally forms folds cris-crossing the recess, only rarely, does one find mucosal scars, resulting from trauma or previous diseases (diphtheria, syphilis).

The mucosa always contains abundant lymphoid tissue, which may mushroom over the orifice of the tube. The glands are very numerous in the Rosenmüller fossa. They form a continous layer in the submucosa, which contains here numerous fat cells.

TECHNIQUE OF THE DEMONSTRATION OF THE FOLDS

One starts with the removal of the tonsils and adenoids to acquire more space. Then the soft palate is elevated by the nasopharyngeal speculum of Senturia. Only the edge of the soft palate should be engaged with the speculum. If the speculum is pushed deeply backward, it will override and hide the fold. The salpingopalatine fold should not be looked for on the lateral wall. It is difficult to locate it there. But it is easy to find it on the posterior wall of the soft palate. The best exposure can be achieved by lateral retraction avoiding the posterior nasal spine and the posterior membranous part of the nasal septum. After the bleeding has been controlled, one can insert a No. 3 laryngeal mirror into the nasopharynx and explore the choanae and their surroundings.

The view thereby achieved is really surprising. With direct vision one sees only one surface of the folds. Hence, they give the impression of flatness. The mirror view reveals them in their three dimensional reality. They look like somewhat lumpy sausages, sometimes as thick as a small finger, extending upwards from the dorsal surface of the palate to the roofs of the choanae near their lateral walls.

In order to prevent damage to the tube, it is essential to demonstrate the tubal orifice. As the plicae all take their origin from the tubal ostium they lead without fail into the tubal orifice. The point of the catheter should be placed anterior to the salpingopharyngeal fold between it and the salpingopalatine fold; then advancing the instrument upwards, along the folds, the tip falls into the ostium.

We remove the folds routinely, if they are wider than 5 mm. For this surgical procedure, the most satisfactory instruments are the punches of Meltzer.

There is hardly ever any need for special hemostatis on the denuded base of the folds. The bleeding stops spontaneously, or after a few minutes of pressure with packing.

SUMMARY

The anatomy and histology of the plicae, Rosenmüller's fossa and the tubal ostium are reviewed.

The technique of the demonstration of the plicae is presented. It is advised that a laryngeal mirror be used during the operation to visualize the choanae and the part of the salpingonasal folds which cannot be seen by direct vision.

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XVI

THE BED-END MANNER

(The following is reprinted, with the gracious consent of its editor, from THE LANCET *of November 28, 1953. It is by one of the (anonymous) "Peripatetic Correspondents" whose pungent commentaries on the passing scene, although gathered under the heading "In England Now," have gained for them an appreciative international audience.—Ed.)*

Many people have noted the decline of that fine old medical institution, the Bedside Manner; but no-one has recorded the rapid and significant rise of its usurper, the Bed-end Manner. Yet this new technique of commenting on patients' lesions, treatment, and prognosis from the foot of the bed rather than from the side is one of the really big developments in Medicine in the past couple of decades. The phrase is a complete comment on the gradual abandonment of physical signs and the substitution for them of the broad-spectrum (if I may use a popular word) investigation.

It is in hospitals that the Bed-end Manner flourishes, and I have seen some of its finest examples in the teaching hospitals. The first important principle is that no doctor shall approach a patient alone: all approaches must be made en masse during the Grand Round. This effectively prevents any single doctor from speaking confidential and comforting, if highly unscientific, words to the patient. This means in effect that nobody ever speaks to the recumbent victim except an occasional wardmaid and the man with the newspapers. No doctor must utter a sound, since it is obviously "someone else's duty to undertake that type of thing." The en-masse approach also prevents a salutation at any level between physician and patient, because as the caravan approaches the bed the Chief stage-whispers "What is she?", the menial turns to answer the question, and the golden moment is gone.

History-taking, a transient and ever-dwindling procedure, may still be undertaken by a house-officer in the lamentable absence of a dictaphone or a suitable "cross out that which does not apply" type of questionnaire. But happily many other scientific devices for keeping the doctor from the patient have been perfected. Auscultation is unnecessary in view of the electrophonograh; the electrocardiograph gives us the pulse-rate, and the lowered serum-potassium tells us that it is full. The barium meal shows us the cause of his vomiting, and the ventriculograms give a cause, if not the original one, for head-

aches. "His cardiac catheterisation leaves us in some doubt, Sir." "Yes, yes, ahem, you'd better repeat it." Pulse charts and temperature charts are consulted only if the patient is seriously ill and the diagnosis obscure; and much of the value of the latter is lost by the enthusiasm of the house-officer, who achieves uniformity of temperature throughout the ward by giving massive doses of the latest 'mycin to every patient. By these means all moves to the bedside are obviated, unless to remove a bedpan or on some similar mission—duties that are carried out at an appropriate level.

Above and beyond all, the patient must be told nothing. If he is in a surgical ward and has keen hearing, he may catch the word "Thursday," which means that he will have his operation on Thursday. If he is in a medical ward, he may hear the explanatory remark "catechol amines" which means that he will have his cate . . . (whatever they are) estimated.

The Bed-end Manner is a sign of changed medical times all right. Still one can't help feeling—just now and then of course—that this change means more to the patient than antibiotics, anesthetics, electrolytes, psychiatrists, old uncle Tom Cobbleigh and all. Graph-paper has replaced the leech in therapy. Is either ideal?

Clinical Notes

XVII

LETHAL GRANULOMA OF THE NOSE AND FACE

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The purpose of this paper is to report on two cases of idiopathic lethal granulomas of the nose and face. One of these cases was treated intensively with cortisone and ACTH without help. This is contrary to the findings of Moore et al,[1] Hagens et al,[2] and Williams and Hochfilzer.[3]

Stewart[4] summarizes the clinical picture of this fatal disease by stating that it is one of progressive destruction of the nose, face, and pharynx, with little resistance shown by the host. His description of the differential diagnosis, progress, and clinical picture of the disease can hardly be improved upon, and the following cases are typical.

CASE REPORTS

CASE 1.—F. H., a white 53-year-old female, was admitted to St. Luke's Hospital on May 1, 1953, complaining of a stuffy nose, dry throat and fever. Her symptoms started six months before, while visiting in Florida, with stuffiness in the nose, a constricting band-like intermittent type of headache, and a sero-sanguinous foul nasal discharge. She received treatment for sinusitis with x-ray therapy and nose drops without avail. Biopsy while in Florida was not conclusive and she was told that removal of nasal polyps would help the condition. This was done, but relief lasted about one week. Following the nasal polypectomy she returned to her home in Ohio, and continued to use large volumes of various nasal medications, without relief. The nasal stuffiness and sero-sanguineous discharge from the nose became gradually worse, and six weeks before admission she started to have a mild fever of 37.5 to 38 degrees centigrade, orally. Because of this fever she received many injections of penicillin and streptomycin; several courses of terramycin, aureomycin, and chloromycetin; and various types of sulfonamides, without help.

The patient's past history revealed that she was a registered nurse, had had an appendectomy, hysterectomy, and tonsillectomy, had never had tuberculosis, syphilis, brucellosis, allergies, or any other serious illness previous to the present difficulty. She stated that she had been in good health until six months before admission.

Examination. Physical examination revealed a well nourished 53-year-old white female with a very stuffy nose, foul odor to her breath, and a serosanguinous discharge from both nostrils. Examination of the nose showed a granulomatous lesion with much crusting involving the nasal septum, olfactory cleft, and lateral walls of the nose, worse on the left side. After removing the crusts, the bare bone of the vomer and the perpendicular plate of the ethmoid could be palpated and this bare bone felt necrotic and loose. The pale crusty granulomatous tissue bled easily on palpation, and the inferior and middle turbinates were engorged and hyperemic with much gelatinous exudate clinging to their surfaces. The nasopharynx was also involved in the process. Both ear canals and drums were normal in appearance, and her hearing was good. The laryngeal examination was normal. The frontal and maxillary sinuses were hazy on transillumination, and the nose was tender to touch. The liver, spleen, and lymphatic glands were not palpably enlarged, and no abnormal neurological signs could be found. The rest of the physical examination was not abnormal, and the temperature was 38 degrees rectally.

Roentgenograms of the chest, skull, genito-urinary system, and paranasal sinuses revealed only a moderate thickening of the mucosa of the paranasal sinuses, with a fluid level in the left antrum. Blood studies of all types were normal. Tests for lupus erythematosis, syphilis, brucellosis, tuberculosis, histoplasmosis, and malaria were negative. Aerobic and anaerobic cultures of the blood and nasal tissues and secretions showed nothing but staphylococcus albus in the nasal secretions. Three different extensive biopsies taken at various times from parts of the septum and lateral nasal wall showed a necrotizing non-specific granuloma, with bony sequestration of the septum and ethmoid areas.

Hospital Course. The patient remained fairly comfortable throughout her hospital stay of forty days, despite the gradual extension of the lesion. This eroded through the base of the nose into the soft tissues beneath the left eye and lachrymal region, with ulceration and necrosis of the left lower lid area of the eye, the lateral wall of the left side of the nose, and a butterfly like spread across the bridge of the nose. Each day the temperature ranged irregularly

Fig. 1, Case 1.—Photomicrograph showing typical section of the necrotizing granulomatous lesion from the nasal mucosa.

from 37.5 to 40.5 degrees centigrade in a picket fence curve with chilly feelings but no true chills. On the tenth hospital day the patient was started on 500,000 units of regular penicillin every three hours (four million units per day) for six days, without any appreciable change in the fever or in the patient's condition. On the seventeenth hospital day, 250 mgm of streptomycin and 200 mgm of erythromycin every four hours were added, without results. On the twenty-second day, ACTH gel, 40 units per day was started, with an immediate drop of the temperature to a lower level, where it ranged from 37 to 38 degrees, and the patient felt subjectively fine. However the lesion continued slowly to progress and on the twenty-eighth day (after six days of ACTH) the patient was shifted to cortisone, 25 mgm every four hours, and the temperature promptly started its picket fence march to 39 to 40 degrees centigrade each day. The patient felt fine but the lesion continued to increase in size, and so after seven days of cortisone, and on the thirty-fifth

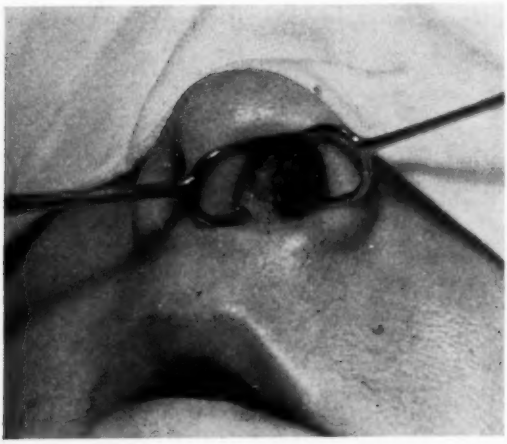

Fig. 2, Case 1.—Photograph showing the appearance of the left naris on admission.

hospital day, the patient was returned to 60 units of ACTH gel per day, with prompt regression of the fever and a great increase in well being. Nevertheless the lesion slowly progressed until the left eye was completely closed. Due to our inability to control the lesion and the death of the patient's husband of a coronary thrombosis, it was decided to transfer the patient on ACTH to her sisters in Dayton, Ohio, where she was to continue under the care of Dr. Harry King.

In Dayton the patient continued her downhill course, depite the ACTH therapy, until she died on August 1, 1953, in the Miami Valley Hospital, Dayton, Ohio, eleven months after the onset of the disease.

Autopsy. The autopsy showed an ulcerated granuloma measuring 4.5 x 8 cm over the bridge of the nose and the left inner canthus of the eye, involving the nasal cartilages, the entire nasal mucosa of the nose, the paranasal sinuses, with the absence of most of the nasal septum, ulceration of the hard palate, and extension into the nasopharynx. The cribriform plate of the ethmoid was intact and the brain was not involved. The bronchi, trachea, lungs, spleen, liver, kidneys, and other organs were not involved. The adrenals were hyperplastic and weighed fifteen grams each. Large amounts of partially digested blood were found in the intestines and stomach.

Figure 1 shows a typical section of the nasal biopsy. Figure 2 shows the appearance of the naris on admission.

CASE 2.—L. P., a white 43-year-old female, was admitted to St. Luke's Hospital on the November 1, 1949, complaining of a stuffy nose, pain in the left face, and a swollen left eye. Her symptoms started one month before admission with pain in the left face, for which she went to a dentist and had three lower teeth extracted, without relief. She had sinusitis in the past and thought that this was a recurrent attack. Pain in the face with increasing nasal stuffiness and purulent foul discharge gradually progressed, and she was given penicillin. In the four days before admission the left eye became swollen and tender.

The past history was normal, except for a history of sinusitis twenty years ago, and that she had her sinuses "cleaned out" five years ago. No history of allergy could be obtained.

Examination. Physical examination revealed a white obese female with erythema and swelling of the left eye, unable to breathe through her nose, from which dripped a foul purulent discharge. There was little pain on pressure about the eye, but a tender hard mass was palpable deep to the left inner canthus of the eye. The nose was blocked by easily bleeding friable tissue in both nares. The turbinates were swollen and hyperemic with much sero-sanguineous foul discharge covering their surfaces. The sinuses were dark to transillumination. The lesion was not visible in the nasopharynx but much redness and inflammation was evident. The larynx, ear canals and drums were normal. The chest, heart, and abdominal examinations were normal. There existed a necrotic granulomatous ulcer, 4 x 5 cm in size on the inner aspect of the right thigh of unknown duration. All reflexes were normal and no palpable lymphatic glands could be found. The liver and spleen were not palpable and no other physical abnormalities could be discovered. Temperature was 37.2 degrees centigrade, rectally, and the pulse, blood pressure, and respirations were normal. Blood serology, cultures, chemistry, and counts were normal.

Hospital Course. On the second hospital day, because of the swelling about the left eye and pain, the patient was taken to surgery and the left frontal sinus trephined through the inner canthus and much free pus obtained. Biopsies of the granulomatous mass in the frontal sinus and both nares were taken with numerous cultures. A biopsy of the lesion of the left thigh was also taken with cultures. Following the biopsies and trephine the patient's condition did not improve. She had a "picket fence" type of temperature,

Fig. 3.—Photograph showing the gross appearance of the pharynx, larynx, trachea, and bronchi in Case 2.

usually up to 39 degrees centigrade each evening with increasing cough, mild chills, and sweating. All tests for brucellosis, histoplasmosis, tuberculosis, lymphogranuloma inguinalae, anaerobic and aerobic cultures, special cultures for fungi and yeasts, animal cultures, smears and cultures of sputum, blood cultures, and x-rays were of no help. Large doses of penicillin, aureomycin, streptomycin, and potassium iodide did not alter the course of the disease. (Note: cortisone or ACTH was not available to give at this time.) The biopsies from the leg, frontal sinus, and nares all showed the same pathological picture of a granulomatous necrotizing lesion of unknown etiology. These findings were confirmed by repeated biopsies.

On the fifteenth hospital day the patient took a turn for the worse and the temperature rose to 40 degrees centigrade, and fluctuated only slightly below this level until death on the twenty-third hospital day. During the last eight days of her illness the edema of the eyes increased with some exophthalmos. The thigh ulcer gradually extended to 8 x 11 cm, the trephine area broke down, and ulcerated, as did the area of the inner canthus of the eye, eye lids, and lateral nasal wall. The liver and spleen became palpable and a palpable tender mass developed on the left upper arm. Blood studies did not indicate any evidence of a blood dyscrasia, though the white count rose to 17,000. The nasal ulcerations increased and extended until the roof of the mouth was ulcerated. A brassy cough with labored respirations indicated the approaching end. The last three days of life gave the impression of a toxic disease with marked extension of the edema of the eyes, exophthalmos, swelling of the left side of the face, mandible and forehead, increasing respiratory distress and mental confusion. No bacterial or other cause could be found, and supportative transfusions were a failure. The entire course of the disease lasted two months.

Autopsy. The autopsy was complete and the following summary is presented: Many special stains of various types were used in an effort to identify possible bacterial, yeast, fungi, or spirochetal organisms in the various lesions without success. Grossly and microscopically there were many granulomatous, necrotizing lesions of unknown etiology involving the nose, paranasal sinuses, dura of the left frontal area, orbits, eye lids, palate, pharynx, larynx, trachea, bronchi, lungs, and skin and the subcutaneous region of the right femoral area of the thigh. The spleen, liver, pancreas, and kidneys showed an acute toxic type of focal necrosis. No evidence of the lesions could be found in the brain, spinal cord, vascular system, lymphatic glands, bone marrow, endocrine glands, genito-urinary, or

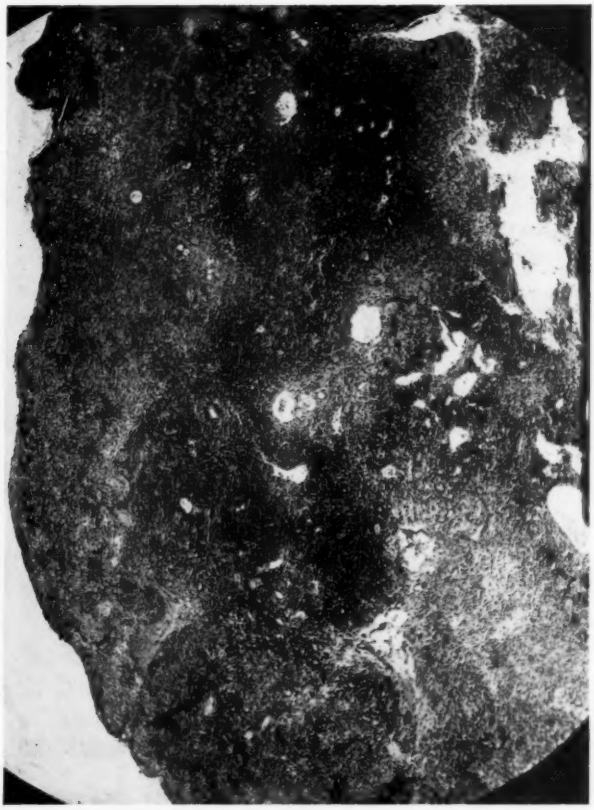

Fig. 4, Case 2.—Low-power photomicrograph showing the appearance of the necrotizing granulomatous lesion taken from the left frontal sinus.

gastro-intestinal systems. The etiology remains a complete mystery.

Figure 3 shows the appearance of the pharynx, larynx, trachea, and bronchi in the gross specimen of this case. Figure 4 shows the appearance of the biopsy from Case 2.

COMMENT

Moore et al treated their case with cortisone and then shifted to ACTH with a remission of symptoms lasting several months but since then the patient has died of the disease (as per personal communication with Dr. Moore). Williams and Hochfilzer reported a similar remission in a long-lasting case which was more favorable though they state that the ultimate cure was not considered as established at the time of the report. Hagens et al[5] report one case with excellent results of seven months' duration.

It is felt that the patient who received cortisone and ACTH was subjectively better, but did not respond to the therapy of either of these drugs in an objective manner. The primary interest in Case 2, which did not receive any hormone, was the fulminating course of the disease.

SUMMARY

Two cases of lethal idiopathic granulomas of the nose and face are presented, both occurring in females.

One case was treated intensively with cortisone and ACTH without cure.

It is felt by the author that the hormones ACTH (corticotropine) and cortisone in treating these cases may not be as effective as suggested in the past.

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XVIII

OSTEOMYELITIS OF THE FRONTAL BONE OF RHINOGENIC ORIGIN

A REPORT OF THREE CASES

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A monumental paper on this subject was presented by Harris P. Mosher and Delbert K. Judd[1] in 1933. In this publication Mosher gave credit to previous papers by Furstenberg,[2] Wilensky,[3] McKenzie[4, 5] and Bulson.[6] To quote from Mosher, "This paper is essentially clinical. It is built around the following main points, namely, that edema of the soft tissue of the forehead is the first sign of infection of the medulla of the bone and of the periosteum; that the edema is a practical guide to the extent of bone to be removed; that the x-ray does not give positive findings until necrosis occurs, and, therefore, is not positive until 7-10 days after the edema has shown infection of the medulla; and, lastly; that radical operation, multiple radical operations, if necessary, offers the best chance of success."

Mosher reported in detail, the pathological findings, histology of the bone, and pathways of infection in seven cases and advised the following: "Operate early and thoroughly, that is, radically. Don't waste a week waiting for a positive x-ray. Begin the removal of bone above the edema. Work down, not up; from normal bone to diseased bone. Remember that osteomyelitis writes across the patient's brow not only the diagnosis but the treatment."

Times have changed with antibiotic treatment and possibly a change in virulence of the micro-organisms. There was no edema in the following three cases and x-rays were equivocal in two cases.

CASE 1.—A thirteen year old right-handed boy N. M. was admitted to the Eye and Ear infirmary December 26, 1952 because of severe right frontal headache of five days duration following a fortnight's head cold.

The child had been listless with no appetite for five or six days prior to admission, and had vomited once. He had received no antibiotics until the day before entry, when penicillin and Gantrisin were

Fig. 1, Case 1.—X-ray shows a loss of outline of the right frontal sinus.

Fig. 2, Case 1.—This picture shows the amount of bone removed on January 9, 1953.

started. His previous admissions here were for peritonsillar abscess in 1948 and for tonsillectomy and adenoidectomy in 1949, and laceration of the right thumb in 1950. He had suffered occasional headaches for many years, which were relieved by aspirin and Anacin. He was struck in the forehead by a basketball five or six days before coming here and exhibited a small lump in the center of his forehead just above the eyebrows.

On admission he was drowsy but oriented and cooperative. His temperature was 99; pulse 50-60; respiration 16-20. There was no pus in the nose but there was tenderness to pressure over both frontal sinuses and x-rays of the sinuses showed pus in both frontals with a loss of the inter-sinus partition (MacMillan). Neurological examination was negative—rough fields and fundi were negative. L. P. 300 i.p. with no cells; sugar 93 mg%; total protein 22 mg%; an E. E. G. was diffusely abnormal with no emerging focus.

On December 29, 1952 a trephination of the right frontal sinus was done, under gas-oxygen-ether. An incision was made in the right eyebrow curving down onto the side of the nose and a trephination was made into the anterior wall of the right frontal sinus. Thick pus came forth under pressure. This opening was enlarged on the

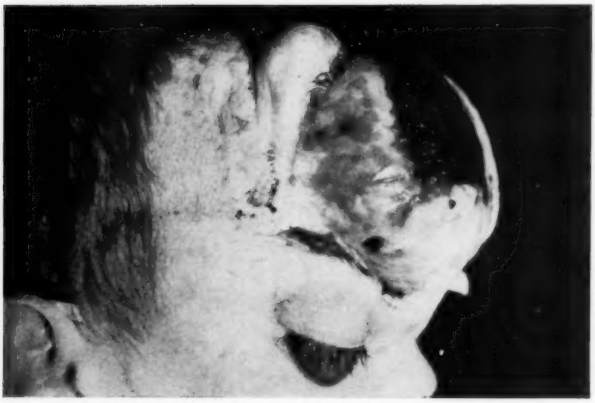

Fig. 3, Case 1.—Picture taken immediately after death.

anterior wall and the floor, to three centimeters, and it was established that the inter-sinus partition was absent, from disease, and that an area 2.5 cm in diameter in the midline on the posterior wall of the sinuses was absent. This exposed a small area of the dura of each frontal lobe. In depressing the dura from the edges of this granular area no evidence of extradural abscess was found.

A plastic tube was left in the frontal sinuses and the incision was closed about it.

Culture showed coagulate positive hemolytic staphylococcus aureus, sensitive to penicillin, streptomycin and chloromycetin.

The patient was given, daily, two million units of penicillin and 1 gm of streptomycin, alternating with dihydrostreptomycin. Repeat x-rays at weekly intervals over the next several weeks showed no osteomyelitis and there was never any edema of the forehead or scalp.

The boy developed more signs of increasing intracranial pressure with papilledema but the cerebral spinal fluid remained clear, with a pressure of 400 and no cells. Total protein and sugar were normal.

On January 5, 1953 a ventriculogram failed to show a brain abscess. On January 9, 1953 following another lumbar puncture,

pressure cone signs developed with a left hemiparesis, and a ventricular tap was successful after seven attempts by the neurosurgical service, but the ventricles were compressed, not dilated, and only a small amount of fluid was obtained. Immediately the patient was taken to our operating room; the frontal bones were exposed and extensive osteomyelitis with pus in the diploe was found. The radical removal was satisfactorily carried out, except that there was some question about the bone over the roof of each orbit. The right frontal lobe was tapped and no abscess was found.

There were granulations over the dura and a culture from these showed a staphylococcus aureus, now insensitive to all antibiotics except Iotycin and Magnamycin. Large doses of each were tried in the next seven weeks and immunal transfusions were also given.

After this large decompression the patient improved for a time but the frontal lobes became pinched off and the clinical picture began to suggest thrombo-phlebitis and cerebritis. We suspected the superior longitudinal sinus and the cavernous sinus, as the right upper eye lid began to swell and the right eye became proptosed. The exposed dura was thick, very firm, tense and hard.

Repeated blood cultures were negative and the ophthalmologists assured us that there was no cavernous sinus thrombosis. Anticoagulants were not ordered but seriously considered and discussed.

On February 3, 1953 osteomyelitic bone with sequestra were removed from the roof of each orbit back toward the sphenoid bone and the right frontal lobe was again tapped, with negative results.

The patient died on March 3, 1953. Autopsy showed a malignant glioma involving both frontal lobes of the brain, with a recent infarct.

It is only proper to mention here that there were repeated ophthalmologic, neuro-medical, neuro-surgical, medical and pediatric consultations held during the ten weeks of this boy's illness and not one of us ever suspected a tumor, benign or malignant.

CASE 2.—This case is one of a 35-year-old man E. H. admitted on March 4, 1953. On March 19, 1952 the patient had a bilateral external frontal operation at Woonsocket, Rhode Island hospital, with drainage of an abscess of the left supraorbital area. He was hospitalized for 19 days and followed subsequently until June 30, at which time the patient was discharged. He returned again on October 15, 1952 with a swelling of the right mid-forehead of four days' duration. Osteomyelitis was suspected but x-rays were negative; the swelling subsided without drainage.

Fig. 4, Case 1.—The base of the brain showing the malignant tumor in both frontal lobes.

Fig. 5, Case 1.—A cross-section showing malignant tumor in the frontal lobes and a recent infarct.

On November 12, 1952 swelling of the right forehead recurred. X-rays again showed no osteomyelitis. This time the swelling increased and the patient was re-admitted to the Woonsocket Hospital on November 19, and an incision and drainage of the abscess of the right forehead was carried out. The patient was discharged the following day. He had persistent drainage from this area for a number of weeks. A culture was made and showed a facultative anerobic streptococcus viridans, sensitive to Aureomycin® and Terramycin.® Terramycin was given orally for two weeks.

On January 14, 1953 a tender spot appeared on the right forehead just inside the hair line. Another set of roentgenograms was made and no osteomyelitis was noted. On February 11, 1953 the swelling had subsided and the wound had completely healed, with no drainage, and the patient returned to work.

On February 17, 1953 the patient awoke in the morning with a swelling of the forehead again, which had broken and drained in the night. He was then sent to Dr. A. S. MacMillan for x-ray examination. The films showed a loss of outline of the right frontal sinus with an area of osteomyelitis at the right upper margin near the midline where the draining sinus had been and another area of osteomyelitis two inches superiorly toward the vertex. The patient had no untoward signs or symptoms. His temperature, pulse, respiration, blood pressure, and laboratory findings were all normal. He had no headache. His only complaint was the draining sinus over his right forehead. The neurological examination was negative and the fundi and rough fields were normal.

The following day he was operated on. An incision was made in the scalp from ear to ear. The whole of the scalp was turned down forward to the superciliary ridges. Osteomyelitic bone was found and this was removed from the right frontal sinus upward to the extent of about one and a half inches by three and a half inches. A large extradural abscess was found at the vertex with firm adherence at its margin between the dura and the frontal bone. This extradural abscess had been draining down to the sinus tract two or three inches below, at the upper edge of the right frontal sinus. The right frontal sinus contained no pus and the anterior and posterior walls appeared healthy. The periosteum of the scalp was sutured back in place; a drain was inserted from the extradural abscess down the old sinus tract and left in place. Hemolytic coagulate positive staphylococcus aureus was found which was sensitive to Terramycin and Streptomycin. He was given both these drugs for two weeks at the hospital and then released for one month, on Terramycin. He has

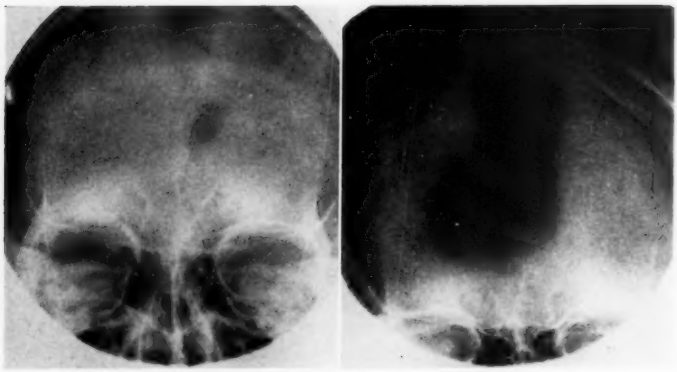

Fig. 6, Case 2.—An x-ray showing two areas of osteomyelitis just prior to operation.

Fig. 7, Case 2.—The amount of bone removed at operation.

been completely well; there have been no untoward signs or symptoms since leaving the hospital. He has reported back every month for observation up to September 1953.

CASE 3.—This is a private patient of Dr. William Sweet. He was admitted to the Massachusetts General Hospital on March 31, 1953. He was a thirteen-year-old right-handed boy who had suffered head colds off and on all winter. Severe frontal headaches developed seventeen days prior to admission. On the third day of the headaches he had had one injection of penicillin and some nasal decongestives. From the 10th to the 13th day after the onset of headache he had daily injections of penicillin. X-rays at this time were said to show disease of the sinus, so he was given daily x-ray treatment for four days and sulfadiazine by mouth for three days. On the fourteenth day the headache increased and vomiting with drowsiness, occurred. He was then sent to Dr. Sweet.

On admission the patient was very drowsy but oriented. There was no pus in the nose. The right frontal sinus was tender on the floor. His blood pressure was 100/60—his pulse ranged between 46 and 52—the temperature was 99—the respiration 16. A lumbar puncture showed an initial pressure of 200 to 220. There were no cells. Total protein was 36 mg%. The fundi showed no choking, and although the veins were congested, the fields were full. There

Fig. 8, Case 3.—An x-ray showing loss of outline of the right frontal sinus.

Fig. 9, Case 3.—An x-ray showing extent of diseased bone that was removed six months previously and with rib grafts in place after six months.

was a slight weakness of the left arm. X-rays of his sinuses showed a cloudiness of the right frontal sinuses with loss of outline and a questionable soft spot in the bone at the upper inner margin of the right frontal sinus (MacMillan).

An incision was immediately made through the right eyebrow across the midline.

The right frontal sinus was opened by removing its anterior wall. There was no pus but the lining membrane was thickened and a soft spot was found on the posterior wall of the right frontal sinus at its upper margin near the midline. The entire posterior bony wall was removed beginning at this soft spot and a very extensive extradural abscess was encountered over the right frontal lobe dura. The inter-sinus partition was intact.

This large extradural abscess was uncovered and it extended upward and laterally under the frontal bone. About an ounce of thick pus was obtained covering thick granular dura. This extradural abscess was not walled off superiorly or laterally. A centimeter of bone

was removed from the margin of the right frontal sinus superiorly and laterally and there was no pus between the two tables. This bone appeared healthly. It was decided to put a drain in and wait 24 hours. X-rays had shown no definite osteomyelitis and there was no edema. At the end of about 26 hours the boy's condition worsened and there were signs of increasing intra-cranial pressure, with a slow pulse and Cheyne-Stokes respirations. The neurosurgeons in turning down a flap over the superior part of the right frontal lobe encountered pus between the two tables of the frontal bone at the vertex. All of the osteomyelitic bone was removed and a large extradural abscess was encountered again, connected with a deep brain abscess. Apparently the brain abscess and the extradural abscess occurred simultaneously. The organism was an anerobic non-hemolytic streptococcus sensitive to penicillin and streptomycin. These antibiotics were used after both operations and at the end of two weeks the boy was practically well. The weakness of his left arm had disappeared; the only complication was bilateral external rectus paralysis from pressure, which gradually cleared.

CONCLUSIONS

1. We may no longer expect to find the classical edema heretofore associated by Mosher with osteomyelitis of the frontal bone.

2. The x-rays may not show osteomyelitis as soon as we previously expected it or it may not show at all. We have always felt that the x-ray evidence lagged a week behind the disease.

3. If there is osteomyelitis over a walled-off extradural abscess, the margin may be the boundary between healthy and diseased bone, but if the extradural abscess is not walled off and there are signs of intracranial complications, we should remove frontal bone radically and look at the dura.

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XIX

BILATERAL PARALYSIS OF THE TONGUE WITH CASE REPORT

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Although the tongue is probably the most frequently observed organ in the body, its diagnostic significance in medical circles has gradually declined. Our predecessors frequently made diagnoses by observing the condition of the tongue. Accuracy in diagnosis has undoubtedly improved much with our varied and sometimes complicated armamentarium; however, a simple tongue blade still maintains its usefulness.

The tongue is an organ of considerable complexity. It can easily be observed but is frequently unappreciated and slighted. Its use in articulation, deglutition, mastication, respiration, salivation, and taste reveals its varied functions. Its unusual motility, its complex muscular structure, and its importance as a speech aid in social contacts serve to further illustrate its importance. Although Goldstein[1] and others have shown it is not absolutely indispensable as an organ of articulate speech, certainly it normally is vital in this function.

It is beyond the scope of this article to present a review of the anatomy of this organ. Such can readily be obtained in the anatomical textbooks. An excellent review of the phylogenetic development of the tongue is given by Keaster[2] and McGregor.[3]

In a review of the available literature back to 1916 no case could be found of bilateral hypoglossal nerve paralysis which was not associated with other nerve involvement or systemic symptoms. There were reports of cases, usually unilateral, following attacks of diphtheria, typhoid fever, after mercury and lead poisoning, associated with hemiplegia, syphilis, trauma, tuberculosis of the skull or cervical spines, and hydatid cysts or tumors near the exit of the nerve from the skull or in the neck.

Paralysis of the tongue without other associated paralytic findings usually denotes a peripheral lesion; however, this is usually uni-

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lateral. It may be one of the early symptoms of central nervous system disease, such as bulbar paralysis, amyotrophic sclerosis, and progressive pseudobulbar paralysis.[4] Difficulties in movement of the tongue associated with other disturbances of the lip, palate, cheeks, and jaws are seen in these various diseases. The nuclei controlling the innervation of the muscles of these parts are involved.[5] There are various syndromes associated with laryngeal paralysis which also include paralysis of the hypoglossal nerve (Collet, Jackson, Schmidt and Tapia).[6]

REPORT OF A CASE

A 64-year-old white man was admitted to Walter Reed Army Hospital January 29, 1953, because of his inability to move his tongue, difficulty in swallowing and in speaking. These complaints developed after a fall from a truck one month earlier at which time he incurred fractures of four left lower ribs. He denied having struck his head or neck, or being unconscious, or noticing the presence of the aforementioned complaints until a couple of days after the fall. He consistently denied other trauma or symptoms both before and after the accident. Since the question of possible medico-legal motives arose, a check-up revealed that he had had a routine examination a few months before and no indications of the present illness had been found. The one and only important contributory factor in this case was that of a previous admission to this hospital on February 8, 1949. At that time a diagnosis of squamous cell carcinoma of the superior pole of the left tonsil and soft palate, of a well differentiated type, had been made. External irradiation to both sides of the neck—a total of 6856 roentgen tumor doses in 35 days—had been given. The patient had been discharged April 8, 1949, without evidence of tumor. On follow-up examinations no evidence of recurrence had been found.

Physical Examination: The only positive findings were a garbled speech, dysphagia, and a paling of the skin on both sides of the upper neck with telangiectases as evidence of previous irradiation. Firm induration of both sides of the upper neck was present without evidence of cervical lymphadenopathy. There was complete flaccidity of the tongue in the floor of the mouth with evidence of partial atrophy. The tongue was smooth and the papillae atrophic. No tongue movements could be elicited. In the valleculae a mucopurulent pooling was present with a velvety redness to the mucosa. Pharyngeal, laryngeal, and palatal movements were normal as well as the taste and touch sensations. Neurological and physical examinations were otherwise normal.

Laboratory Data: Routine serology, blood count, and urinalysis were normal. X-rays of the skull, neck, chest, and skeleton were normal except for healed fractures of the left seventh, eighth, ninth and tenth ribs. An electroencephalogram was reported as normal.

Hospital Course: After considerable study, observation, consultations, and a negative aspiration biopsy of the indurated area of the left side of the neck, it was decided that an exploration of the neck with biopsy should be carried out. On March 13, 1953, an exploration of the right side of the neck was done. Marked scar tissue was encountered surrounding a moderately atrophied hypoglossal nerve. The nerve was carefully freed throughout its course in the neck. Biopsy revealed scar tissue. The postoperative course was uneventful and by the ninth day the patient stated proudly that he could move his tongue. Movement of the tongue was difficult but definitely present. This, of course, was not anticipated so soon. The tongue could be extended past the lips approximately one inch with preponderant movement being on the right side of the tongue. The patient was encouraged in tongue exercises. Subjectively, he felt his speech and swallowing were improved which, of course, could be explained mostly on a compensatory basis and was more relative than actual. He was discharged from the hospital on March 27, 1953 and will be readmitted for neurolysis on the left side at a later date if he can be persuaded to return to the hospital.

SUMMARY

A case of total bilateral hypoglossal paralysis unassociated with other active neurological or systemic disease is presented. Although no similar case report has been found in the literature, this particular one is presented because it is felt that other similar cases secondary to postirradiation cicatricial involvement of nerves most certainly must be seen occasionally. The coincidental and seemingly sudden and bilateral onset of hypoglossal paralysis in this case is not readily explained. The most likely conjecture is that paresis had started on one side but had not subjectively caused symptoms, and that later paralysis of the other side had occurred. In this case a careful review of the history failed to corroborate this in any way.

4117 36TH ST.

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XX

LYMPHOSARCOMA OF THE TONSIL IN CHILDREN

REVIEW OF THE LITERATURE AND REPORT OF A CASE

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Lymphosarcoma of the tonsil is an uncommon tumor and its appearance in children is an extremely rare event. A review of the literature has revealed only six such cases.[1-6] All of these were boys, and all ended fatally a few weeks to about four months after seeking medical aid.

PREVIOUSLY REPORTED CASES

Cline[1] in 1911 described a 22 months old boy who had had a swelling of the mandible for ten days and, for a week, difficulty in breathing while recumbent. Examination revealed a nodular, soft, easily bleeding left tonsil almost filling the pharynx. There were also large neck glands. A tonsillectomy was done with improvement in breathing. Sixteen days after the operation the growth was again spreading and death occurred within one month. Pathology report was lymphosarcoma. The clinical course probably dated from a "tonsillar abscess" two months before first being seen by Cline and apparently was of approximately three months' duration.

Chappell[2] in 1931 reported the case of a seven year old white boy who was first seen three weeks prior to hospital admission and treated at that time for Vincent's angina. Examination showed a large, firm, purple, easily bleeding mass the size of a golf ball in the left tonsillar region. Eight days after admission, a tonsillectomy was performed. Seventeen days later a cauliflower mass appeared in the fossa extending into the soft palate. X-ray therapy was then given without apparent decrease in size. Electrocoagulation of the mass was followed by death from sepsis 54 days after admission. The first biopsy "suggests maligancy be kept in mind" but "some normal tonsil tissue is present." The second biopsy was diagnosed lymphosarcoma. The clinical course was approximately three months.

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Chappell cites Kaufman[3] from a University in Sweden who reported a "lymphosarcoma the size of a plum in the throat of a five year old boy." No other details are available.

Lopez[4] in 1941 reported the case of a three year old white boy who had fever, loss of weight and a growing mass on the right side of the neck for two months. Examination revealed a lobulated, fairly hard mass about the size of a tangerine in the right carotid region. There was also a tumefaction "about the size of a nut" invading the right tonsil and anterior pillar pushing the uvula to the left. Five days after admission he tried unsuccessfully to evacuate the soft friable caseous right tonsil. The patient was then transferred for x-ray therapy but a few days later developed dyspnea and died in spite of tracheotomy. The clinical course was approximately two and one-half months. Surgical tissue showed lymphosarcoma. The blood picture was negative except for anemia.

Morwitz[5] in 1947 reported a case of a three year old white boy who had a rapidly growing left tonsil with increasing respiratory effort, both of about one month's duration. Examination revealed a nasopharynx almost closed by a large, smooth, soft but not friable left tonsil. There were slightly enlarged non-tender left cervical nodes and also some respiratory stridor when lying down. The nose was full of mucoid discharge. Seven days later a tonsillectomy was done. One month subsequent to this a large irregular friable mass was found in the left fossa, the cervical glands were large and there was anemia. The patient received x-ray treatment and a tracheotomy was performed but he died 129 days after first being seen. The first biopsy showed "hypertrophy and chronic inflammation;" the second, lymphosarcoma. Autopsy revealed generalized lymphosarcomatosis particularly evident in the left cervical nodes, left kidney and mesenteric glands. The clinical course was of five to six months duration.

Hirst and Charland[6] in 1951 reported the case of a four year old white boy who was found to have a mass in the region of the right tonsil with associated cervical adenopathy. A biopsy showed lymphosarcoma. He was given x-ray therapy with disappearance of the mass and the adenopathy. He then developed anemia, masses in the parotid gland region and a palpable spleen. Death occurred 153 days after the mass was first noticed. Six days prior to death the blood count was 1,850,000 red blood cells, 4 grams of hemoglobin and 100,000 white blood cells with 99 per cent embryonic lymphocytes. Diagnosis was acute lympholeukemia.

The following single case is deemed worthy of presentation because it appears to be the seventh tumor of this type reported in a child; it is the first to be described in a girl; it illustrates the onset of such a malignancy at the extremely early age of two and one half years; and it outlines the typical course of the disease.

REPORT OF A CASE

This white girl, aged two years and seven months, was admitted to Children's Hospital, Los Angeles, on February 14, 1950. One month prior to admission the child had a cold and sore throat. Shortly thereafter there appeared a swelling over the left side of the neck which was treated by several doctors, including one who gave "electric tests" without relief. The rest of the therapy was mainly intermittent administration of sulfonamides and penicillin. About two days prior to admission, the neck mass increased greatly in size, the throat became quite painful, and there was a definite decrease in fluid and solid intake.

The rest of the personal history and the family history were otherwise noncontributory.

Examination on admission revealed a fairly well-nourished child weighing 33 pounds with a temperature of 99.8 rectally. There were no signs of toxemia. Both tonsils were large but the left one was huge, being two times the size of the right one and extending just past the midline. It was soft but not friable and was partially covered by a thick patchy grey membrane. The areas not covered by this membrane were very red and cryptic. The pharynx, palate, teeth and tongue were negative.

There was an 8 x 7 cm well-defined, firm, irregular soft tissue mass overlying the left parotid gland area and the left mandibular body which extended inferiorly below the mandible well into the anterior triangle of the neck and posteriorly to the anterior border of the trapezius muscle. There was no heat or excessive tenderness but the center was definitely fluctuant. The mass as a whole was only slightly movable but did not appear fixed to the mandible. There were no neck nodes palpable on the right side and only a few shotty nodes were felt on the left.

The child was given crysticillin 300,000 units daily, triple sulfa 5 grains (sulfadiazine), sulfamerazine and sulfathiazole in equal amounts) every four hours, as supportive and symptomatic treatment. A throat smear taken the day of admission grew H. staphylycoccus aureus coagulase positive. Because the tonsil remained huge, the cervical mass became steadily larger, and the course was afebrile,

Fig. 1.—The tumor mass at its biggest just prior to x-ray therapy. There is a network of blue vessels on the surface.

on February 21, 1950 (one week after admission) a diagnostic tonsillectomy was done followed by biopsy of the neck mass. The tonsil was removed easily by the guillotine method. It was fairly soft and meaty to the touch. The fossa was clean and smooth. When the cervical mass was incised, a large unilocular cavity was entered which extended superiorly deep to the mandible and downward to the obvious limit of the growth. The cavity contained much suppurative fluid and grey, necrotic, pultaceous material.

Following surgery, the mass decreased in size for a few days and then continued to grow until on March 8, 1950 it was approximately 13 by 16 centimeters. By this time its surface was covered by a well-defined bluish vascular network. During this period there was much indecision as to the interpretation of the biopsies. The tissues from both tonsil and neck mass were studied by four qualified pathologists all of whom were certified by the American Board of Path-

ology. Three of these thought there was only "reaction to chronic inflammation;" one believed there was lymphosarcoma.

Because of the clinical course, another biopsy was performed on March 10, 1950. Samples were taken from the superficial neck tissues, thick wall and deep center of the tumor. The report was essentially the same from all three: "Specimen shows a monotonous pattern of large cells which resemble lymphocytes except that they are larger than normal lymphocytes. These have relatively little if any cytoplasm. The nuclei are stippled in appearance and are relatively light. Numerous mitotic figures can be seen. Scattered uniformly throughout these cells there are spaces which are pale and contain rather large cells with pale vesicular nuclei and abundant very pale cytoplasm. Impression: Lymphosarcoma."

Postoperatively the child was given x-ray therapy to the neck and throat. A total of 825 roentgens was given from March 15, 1950 to April 3, 1950 in amounts of 75 to 100 roentgens three times weekly. Definite decrease in the size of the mass was noticed following 325 roentgens. The decrease continued with further exposures until the mass was approximately one half its maximum size at the time x-ray therapy was discontinued on April 3, 1950 because of the patient's poor general condition.

In spite of the local response to x-ray, the patient's general course was steadily and quite rapidly downhill. The spleen and liver were both palpable on March 26. On April 3 she had three episodes of coffee ground emesis and died three days later. Permission for autopsy was refused.

The temperature throughout was normal except for slight elevations after surgery and a persistant 101 degree rectal temperature the last week of life.

X-rays of the mandible, skull, and cervical spine were negative. X-rays of the chest on admission and on March 23 were both negative.

Hemoglobin was 13.7 grams on admission and steadily decreased to 9.2 grams just prior to the hematemesis. White blood counts and differentials were always normal. Bone marrow studies were negative. The Kahn, tuberculin skin tests and routine urinalyisis were negative.

DISCUSSION

Diagnosing lymphosarcoma of the tonsil by histopathological examination is a difficult problem. Not only is there the almost impossible task of differentiating a sarcoma from a grade-four squamous

cell carcinoma,[7] but also, because of cellular immaturity, there may be difficulty in determining what type of sarcoma is being examined. The tendency has been to follow the view of Mallory that all types of lymphoblastoma (lymphocytoma lymphoma, lymphosarcoma, lympholeukemia, Hodgkin's disease, plasmocytoma, and giant lymph follicle hyperplasia) are different manifestations of the same disease[8] and to depend at times on the clinical picture for the precise diagnosis.

There is the further problem (as illustrated so well by our experience) of obtaining a "negative" biopsy on the first attempt. This has been emphasized before by Whitcomb[9] who reported seven adult cases in five of which, although the clinical suspicion of malignancy was present, the first biopsy failed to support this impression. The fact that sarcoma arising from the central part of a tonsil may be overlain by normal tissue or that at some stages only one segment of a tonsil may be sarcomatous will help explain the apparent unreliability of some biopsies.

In adults, lymphosarcoma of the tonsil must be differentiated from carcinoma of the anterior pillar, a more common tumor. The importance of this differential lies in the markedly different courses. Lymphosarcoma is rapid-growing, quickly spreads to many groups of glands, and usually causes death by distant metastases in spite of apparent control of the local disease. Carcinoma of the pillars is slow growing, metastasizes to the neck nodes and kills slowly by starvation. If seen early there is a good chance for cure.[9] This differential diagnosis does not appear to be a problem in children, as carcinoma of the anterior pillar does not seem to exist in this age group.

While there are other more common causes of tonsillar asymmetry such as peritonsillar abscess and ulcerating type surface infections, none of these has the serious implications of the disease under discussion. Because of this, when unilateral tonsillar enlargement or marked tonsillar asymmetry is encountered, one should give ample consideration to malignancy in the differential diagnosis. This means that not only should the possibility of malignancy be considered but also the impression of malignancy should not necessarily be discarded following one negative biopsy. This rule is especially applicable if there is a persistent unilateral cervical adenopathy on the side of the growth or if the clinical course indicates a generalized debilitating disease.

The treatment of our patient was the same as that given most of those previously reported namely tonsillectomy followed by x-ray therapy. The outcome in spite of response of the local pathology to treatment was the same as described in all these previous cases.

SUMMARY

1. Lymphosarcoma of the tonsil is reported occurring in a two and one-half year old white girl.

2. A review of the literature shows this is a rapidly and uniformly fatal disease in children with death occurring within six months of clinical onset.

3. Marked tonsillar asymmetry or unilateral tonsillar enlargement should be recognized as a manifestation of malignancy and warrants thorough investigation.

4. A single negative tonsillar biopsy should not be accepted as evidence definitely ruling out malignancy, as this is a fairly common misleading occurrence in lymphosarcoma of the tonsil.

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XXI

PRIMARY AMYLOIDOSIS IN THE LOWER RESPIRATORY TRACT

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DETROIT, MICH.

A case of localized amyloid disposition in the lower respiratory tract, unassociated with generalized wasting or suppurative disease, was recorded as early as 1883. Schottenfeld et al[1] have reviewed the literature and found a total of thirteen cases of amyloid deposition limited to the lower respiratory tract which were substantiated by laboratory study. To this they added one case of their own. Haynes et al[3] reported a case in 1948; Holinger[2] also reported two cases in 1950; and Schmidt et al[4] reported a case in 1953.

In the previously reported cases the age varied from 30 to 76 years with 11 of the patients over 50 years of age. Males predominated in a ratio of 14:4. The symptoms had been present as briefly as 7 weeks to as long as 40 years, and were dependent upon the locality of the amyloid deposits.

In the five cases with laryngeal involvement hoarseness was a prominent symptom, but other symptoms in order of frequency were cough, dyspnea, wheeze, hemoptysis, recurrent pneumonia and bronchiectasis.

As the gross appearance is not diagnostic the diagnosis in all cases was dependent upon pathological study.

The absence of amyloid elsewhere in the body was confirmed by autopsy in 11 cases; the remaining 7 were still alive when reported but showed no evidence of generalized disease on clinical or laboratory study.

In all but three of the cases of tracheobronchial deposition previously reported the amyloid was present in the submucosa and could have been obtained by bronchoscopic biopsy.

In the instances where the gross characteristics of the amyloid deposit were noted the striking feature of the tumor was its rubbery and tough consistency. Staining characteristics were constant and

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aided markedly in establishing the diagnosis in all but one case. Special stains included iodine, iodin and sulphuric acid, as well as methyl violet, gentian violet and congo-red.

It is our privilege to report the 19th case of primary amyloid deposition in the lower respiratory tract.

REPORT OF A CASE

L. A., white, made, 36 years of age. No. 650051. The patient was first seen on July 6, 1951 complaining of a chronic, recurrent cough of six years' duration, more marked during the preceding five months and especially during the two weeks immediately preceding his clinic visit. The cough was present for periods of three to four weeks, with intervals of freedom from cough for one to two weeks. On occasions the cough was so severe his vision blurred. He had noted wheezing at times and localized it to his left side.

Small amounts of yellow sputum were raised during the severe attacks, but hemoptysis had never been noted. He admitted to smoking a package of cigarettes a day for 18-19 years. There had been a 20 pound weight loss during the past six months. His past history indicated the occurrence of pneumonia during infancy, but there had been no long-standing debilitating disease.

He had consulted a number of physicians during the six years of his illness and several x-rays taken during this period were said to have been negative. Numerous cough mixtures, some of which had contained codeine, were ineffective in controlling his cough. Penicillin, sulfonamides and antihistamines had been tried with no benefit.

Examination of the ears, nose and throat failed to reveal any evidence of a chronic infection. The remainder of the general examination revealed positive findings only in the chest, where auscultation revealed moderate diminution of breath sounds and many inspiratory snores at both bases. The lungs were resonant on percussion and expanded freely with normal motion of both diaphragms. Blood and urine examinations showed no deviation from normal values. A chest x-ray was reported as showing only a mild increase in bronchovascular markings in both bases, with no evidence of parenchymal abnormality.

The patient was advised to have a bronchoscopy. On August 7, the first of a series of diagnostic and therapeutic bronchoscopies was performed.

A large tumor mass was noted arising from the anterior wall of the trachea at a point approximately two inches above the carina and

extending distally to invade both main bronchi. The left main bronchus was markedly narrowed by the growth. The gross appearance was strongly suggestive of a low-grade malignancy, but a biopsy later showed an acellular fibrous connective tissue with no evidence of malignancy.

Bronchoscopy was repeated August 8. The masses of tissue were found to be friable and were easily bitten away with a biopsy forceps. Large amounts of the tissue were removed and the base of the tumor was cauterized by means of electro-dessication. Microscopic examination of tissue showed irregular, large, edematous masses of elastic connective tissue infiltrated with numerous lymphocytes and free blood, and with no evidence of malignancy.

The bronchoscopy was repeated August 30. Again large masses of tissue were removed and cautery again was applied. Microscopic study of the tissue removed at this time showed a pale, acidophilic material, which was relatively acellular. Numerous tiny blood channels lined with a single layer of flattened endothelial cells were noted to course through the tissue. In a few areas there were cord-like depositions of dense fibrous connective tissue which were orderly in every instance. Special stains for amyloid failed to give a positive reaction but the pathological diagnosis was given as amyloid tumor. The patient stated that his cough was markedly lessened following this bronchoscopy.

A repeat bronchoscopy was done September 13. As the lip of the bronchoscope was advanced in contact with the trachea wall or bronchus, tissue peeled off in large pieces. At this session the lumina of the trachea and both main bronchi were well freed of any obstruction. Cautery was not used. Under special staining the material submitted for microscopic study appeared positive for amyloid.

A repeat bronchoscopy October 3 again showed large masses of tissue which could be easily peeled off from the walls of the bronchi and trachea. Again the tissue was said to show positive reaction for amyloid and special stains.

At this point it was decided to wait for a period of three months unless symptoms presented before that time. The patient was completely symptom-free during this interval. Bronchoscopy was not repeated until January 3, 1952. Although the mucous membrane at that time appeared considerably hyperemic there was no evidence of tumor found within the lumen of the trachea or either main bronchus.

Repeat bronchoscopy, May 15, showed a small recurrence of the growth on the anterior wall of the lower end of the trachea and in

the right main bronchus. This tissue was removed with ease and the microscopic picture of the tissue was unchanged.

Bronchoscopies repeated on September 4, and December 18 showed no evidence of recurrence of the growth although there was a slight thickening of the mucous membrane and consequent narrowing of the lower end of the trachea.

However on April 23, 1953 there was regrowth in the trachea and both main bronchi which again was removed. There has been a gradual diminution in the calibre of the trachea and both main bronchi, but not to a degree to produce symptoms.

SUMMARY

Eighteen previously reported cases of amyloid deposition in the lower respiratory tract have been reviewed. Ten of these cases were proven only at autopsy and the eleventh and twelfth only after pneumonectomy. In none of these cases was there evidence of amyloid deposition elsewhere in the body and they all must be assumed to be instances of primary amyloid deposition.

A nineteenth case is added to this category and its progress recorded.

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XXII

REMOVAL OF A MASTOID OSTEOMA

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Although osteomas about the face are not unusual, they are more apt to occur within the bony cavities: the orbit, the frontal sinuses, or the antrum. This tumor was situated above the ear, in the tempero-mastoid region.

The temporal bone consists structurally of two main parts, the squamous portion and the mastoid portion. It articulates with the frontal, parietal, and occipital bones and with the larger wing of the sphenoid bone, thus lying on the side of the skull, and representing a small part of the face.

The embryonic development of the bone takes place relatively late, only after that of muscles, nervous tissues, the vascular system and most of the viscera. At this time, the skeleton is composed of hyaline cartilage.

There are two processes by which bones develop. All bones arise primarily from embryonic connective (mesenchymal) tissue. In one type, small gelatinous areas form in the mesenchyme and increase in consistency. In these hyaline areas, calcareous deposits gradually accumulate, around which the young mesenchymal cells multiply and increase in size, to become osteoblasts, or bone-builders. In the other type of bone formation, the ossification takes place directly in the mesenchymal cells, without the mediation of cartilage. The latter is the one which occurs to form the bones of the face and the flat bones of the skull. Consequently, this is the process of bone formation in the temporal bone, which is concerned in this case.

Osteomas are bony tumors, which project above the surrounding surface. They may be inflammatory in origin, or from simple wandering out of osteoblasts from the periosteum. As in this case, the connective tissue stroma becomes hyalin and calcification gradually takes place, with change from osteoid to osseous tissue. The exact classification of these tumors is often difficult since it may be impossible to determine what influence stimulates these connective tissue

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cells to localized bone-building activity, nor what causes a disturbance of calcium metabolism, sometimes considered the cause of osteoma.

The patient, a woman forty-nine years of age, showed nothing of significance either in the history nor the general physical examination. The only single sign was that her fifth and last child was a lithopedion. The four preceding offspring were all living and well. At her first examination, she stated that about two years ago she had noticed a small, pea-sized elevation of the skin above her ear. She noticed that it gradually became larger, and with increasing rapidity, during the past year. She gave it little attention and considered it only an acneiform eruption. It also became increasingly sensitive, and the ear was forced outward. The patient complained of a sharp, shooting and cutting pain in the region of the tumor.

At the time of her office visit, the growth had reached roughly the size of a pigeon's egg. On inspection, it was thought to be a dermal cyst, but when palpated, the consistence was hard, suggesting calcification. The growth was found to be attached to the underlying bone, in the upper mastoid region, near the ear, although the tissue of the auricle was not involved in the growth. The skin over the tumor was smooth, without break or ulceration.

The preoperative x-ray examination reports a dense tissue mass, with the appearance of a cyst, situated over the left mastoid region. There was a definite bone-like structure.

The growth was removed under a local anesthetic. One hour before operation morphine sulphate gr. ¼, with scopolomine hydrobromide gr. 1/150 was given, followed by sodium amytal gr. 3, on call to the operating room. The field was infiltrated with 1 per cent novocaine and 1:30,000 adrenalin. Altogether 30 cc of the anesthetic was injected.

An incision was made extending to the bone. The periosteum was elevated for a distance of about 2 cm on each side of the incision. The growth was separated at its base with a chisel and mallet and forced upward and outward until the mass was freed.

The wound was closed with No. 0 catgut. Nylon sutures were used for the skin.

The pathologist's report described a hemispheric mass of bony tissue measuring 2 x 2 x 1½ cm at its base, with a smooth convex upper surface. On cutting with a knife, the consistence was quite

firm. Microscopic examination, after decalcification, showed normal bone spicules, without evidence of malignancy. The diagnosis was osteoma.

The result of the operation was largely cosmetic, since the tumor created a facial deformity but was non-malignant. The wound healed readily; the distortion about the ear was corrected, and the headaches much relieved, though not wholly remedied.

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XXIII

CEREBROSPINAL-FLUID OTORRHEA TREATED BY AN UNUSUAL METHOD

REPORT OF A CASE

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AND

HENRY W. DODGE, JR., M.D.

ROCHESTER, MINN.

The development of a fistula through which cerebrospinal-fluid is discharged during the postoperative convalescence of neurosurgical patients is a troublesome complication. Although such a fistula may occur at any level of the neuraxis at which the surgical intervention has been carried out, most commonly it is encountered after operative procedures on the cervical part of the spinal column or the posterior cranial fossa. Most physicians are familiar with spontaneous and traumatic cerebrospinal-fluid rhinorrheas,[1] and with the occasional otorrhea that accompanies a basilar fracture of the skull. In our experience, cerebrospinal-fluid otorrhea following total removal of a neurilemmoma of the cerebellopontine angle is unusual, and to the best of our knowledge the use of polyvinyl-formal sponge[2, 3] in the successful closure of such a defect has not been reported previously. For these reasons, it seemed worth while to report such a case which we recently encountered.

REPORT OF A CASE

A 60-year-old white housewife who had been seen at the Mayo Clinic on numerous occasions reregistered in September, 1952, with a main complaint of headaches of eight months' duration and blurred vision of one month's duration. The patient stated that for the previous eight months she had experienced numbness and tingling around the mouth, and on numerous occasions had bitten her tongue because of inability to feel properly on the inside of her mouth. In January,

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1952, she had experienced a feeling of drawing of the left corner of her mouth, and the right side of her face and forehead had become numb and had remained so. After her experiences of January, 1952, she began to have severe occipital headaches from which she was hardly able to obtain relief. At the onset of these headaches, she experienced diplopia and marked blurring of vision. She had suddenly fallen to the floor for no reason. For the few weeks prior to returning to the clinic she had choked easily on eating solid food and had had some difficulty with drinking liquids.

The family history was noncontributory. The past history revealed that the patient had experienced some exertional dyspnea and that she had had hypertension for many years. In 1934, she had undergone an extensive pelvic operation and in 1936 a nasal operation.

The results of clinical examination on admission of the patient in September, 1952, were compatible with the diagnosis of hypertension, obesity and generalized arteriosclerosis. Neurologic examination, roentgenograms of the skull, the results of equilibratory and auditory tests and visual-field studies were compatible with the diagnosis of brain tumor located in the right cerebellopontine angle. On September 2, 1952, it was noted that the patient had choking of the optic disks measured at two diopters on the right and three diopters on the left, and large hemorrhages over both disks. The results of routine laboratory tests were within normal range for a patient of this age.

On September 15, 1952, a right suboccipital craniectomy and decompression was performed and a neurofibroma of the right cerebellopontine angle was completely removed. Because of the complete removal of the tumor and the fact that the seventh and eighth cranial nerves were incorporated in the tumor, it was considered that a spinofacial anastomosis[4] would be necessary at a later date. Owing to the severe involvement of the fifth cranial nerve by the extension of the tumor, it was deemed wise to perform a right blepharorrhaphy to cover the cornea on the right side postoperatively. The patient made an uneventful convalescence and the craniectomy wound healed by primary intention. Subsequently, a spinofacial anastomosis was performed on the right side. The patient tolerated this procedure well and by October 7, 1952, was able to be sent home with her wounds well healed.

The patient returned to the clinic on December 15, 1952, stating that following her return home she had had several bouts of chills and fever, and that on November 10, 1952, a clear, watery discharge began to issue from the right ear. This was accompanied by marked

relief of the pain which she had experienced. Physicians at home administered penicillin and used various nose and throat treatments for relief of the persistent watery discharge from the right ear. It was thought that this was a discharge of cerebrospinal fluid.

On readmission of the patient to the Mayo Clinic the results of neurologic examination were within normal limits except for the postoperative involvement of the fifth, seventh and eighth cranial nerves. The fluid draining from the right ear was examined for sugar and cellular content and proved to be cerebrospinal fluid.

Examination of the ear revealed that cerebrospinal fluid was draining from a small central perforation of the right ear drum. No definitive evidence of active infection could be disclosed, and it seemed most likely that a defect in the mastoid air cells was the cause of this drainage. There was total deafness in the right ear.

It was decided to attempt an intracranial closure of the cerebrospinal fistula, which apparently was the result of removal of the angle tumor and some erosion into the mastoid air cells on the right side. On exploration of the old craniotomy wound on December 19, 1952, no distinct fistula nor any definite opening in the mastoid air cells on the right side was encountered. The dura was dissected completely free from the entire lateral mastoid portion and the site was packed with absorbable gelatin sponge (gelfoam).

Postoperatively the patient made a satisfactory convalescence from the operation. However, although the ear remained dry for several days, subsequent drainage proved that the fistula had not been adequately closed. During this period the patient was on intensive antibiotic therapy. She was also placed on sulfadiazine therapy as an added precaution against infection. Following this, various means of a conservative nature were tried to close the cerebrospinal-fluid fistula: the patient was advised to maintain an erect position during the day, the intake of fluids was severely restricted, mild catharsis was employed and the patient was advised to sleep with her head elevated and with the involved side up—these were unrewarding, however. The drainage of cerebrospinal fluid continued.

Consequently, it was deemed wise to combine the above treatment with the use of an indwelling spinal catheter[5] to drain the subarachnoid spaces as adequately as possible. This procedure was carried out and adequate drainage was obtained, but to no avail. Although the patient would remain dry for periods of time, the drainage persisted. Then the question arose as to the next best method of attack. It was felt that the patient's life was seriously threatened from a

possible intercurrent infection, meningitis, unless the fistulous connection to the outside could be closed. Two methods were open: re-exploration of the craniotomy wound and another attempt made to close the fistulous tract, or exploration of the mastoid air cells with an attempt to obliterate this tract. Because of considerable success in recent months with the use of polyvinyl-formal sponge, a new plastic material which has been found to have numerous uses in neurosurgical patients,[3] it was believed that re-exploration of the old craniotomy wound and application of this sponge to the lateral wall of the posterior fossa over the mastoid air cells was indicated. It was thought that the subsequent growing-in of normal connective tissue into the interstices of the sponge might succeed in closing this fistulous tract.

On January 3, 1953, the old craniotomy wound was re-explored and a double thickness of polyvinyl-formal sponge was applied to the lateral wall of the posterior cranial fossa, over the mastoid area on the right side. Since it takes from seven to twelve days for the sponge to become vascularized and for connective tissue to form in the interstices, it was anticipated that two or three weeks after the operation the cerebrospinal fluid might cease to leak. During this period, treatment consisted of antibiotic therapy, limitation of fluids, and maintenance of the patient in an upright position both day and night.

On the 18th postoperative day the leak of cerebrospinal fluid suddenly ceased. From that time on there was no more leakage from the right ear, the patient rapidly improved, both mentally and physically, and she was able to be returned home on the 24th day after re-exploration and insertion of polyvinyl-formal sponge. To date the patient has gone for more than ten months without evidence of a recurrent leak of the cerebrospinal fluid. She was last re-examined in October, 1953.

Cerebrospinal-fluid otorrhea following an operation in the region of the cerebellopontine angle is uncommon. Dandy,[6] in 1944, reported 5 cases of postoperative cerebrospinal-fluid otorrhea, in four of which the otorrhea followed mastoidectomy; in the fifth it occurred after removal of a tumor of the acoustic nerve.

The last-mentioned case was that of a white man aged 48 years. In 1937, a large tumor of the acoustic nerve was removed. Rhinorrhea appeared and persisted. Dr. Dandy was puzzled that rhinorrhea and not otorrhea developed, and assumed correctly that the fluid in some way had entered the eustachian tube. The patient survived two attacks of meningitis. The cerebellar wound was reopened and

the hollow in the petrous bone was waxed, but without any effect on the leak of cerebrospinal fluid. The ear drum was found bulging with fluid, but it was not stated which ear was affected. Methylene blue was injected into it. A blue-stained fistula was located in the posterior wall of the middle ear. This cartilaginous opening was sutured and the adjacent mastoid waxed. However, the wound broke down with infection. The rhinorrhea (otorrhea) persisted. He had another attack of meningitis and died.

Otorrhea is occasionally seen after an operation on the temporal bone, and in most cases it heals spontaneously. Lillie and Spar,[7] in 1947, reported five cases in which surgical intervention was necessary.

MAYO CLINIC.

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Society Proceedings

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

Meeting of Thursday, February 5, 1953

THE PRESIDENT, DR. LAWRENCE J. LAWSON, IN THE CHAIR

Surgical Treatment of Atresia of the External Canal

PIERCE THEOBALD, M.D.

AND

EUGENE DERLACKI, M.D.

(Abstract)

A motion picture gives details of the surgery performed in this series of cases, and the authors elaborated upon the technique in their discussion. The hope is expressed that the addition of these cases to the available literature will help to improve the results now being obtained in correction of this deformity.

Problems in the Use of Hearing Aids and Recent Trends in Their Solution

RAYMOND CARHART, M.D.

Three of the several problems which patients encounter in the selection of hearing aids are discussed. Each patient should be studied sufficiently to clarify his potential efficiency with a hearing aid, and to indicate clearly the steps which will benefit him.

Some patients have severe intolerance for the stronger sounds produced by hearing aids. Instruments with compression amplification can often meet this difficulty, but actual trial is necessary. Also, there are patients whose discrimination for speech is abnormally poor; many presbyacusics and cases of endolymphatic hydrops fall

in this category. Extensive research is needed to clarify the factors responsible. Other patients have trouble because of unfavorable audiometric configurations, particularly those with markedly greater loss at high rather than at low frequencies. Some degree of selective amplification is desirable, but the details need research confirmation; there are limits to the variation in frequency response in instruments that are available. The disadvantage of unilateral listening results in interference with localization of sound sources and causes imperfect reception in some situations. Many users blame the instrument for this trouble, and others use it with reduced confidence. The solution for this lies in proper patient guidance. Careful audiological assessment and hearing aid evaluation will enable the clinician to assist the patient to understand his problem, and to realize what he may expect from a hearing aid.

The Surgical Management of Carcinoma of the Tongue and Floor of the Mouth

HANS VON LEDEN, M.D.

The high mortality resulting from these lesions can be attributed to the abundant lymph supply which favors early metastases to all parts of the cervical lymphatic system. On the other hand, metastatic involvement of distant areas by hematogenous spread occurs rarely.

Experience has shown that radiation therapy is not an effective weapon in the destruction of carcinomatous extensions in the cervical lymphatic chain. Adequate dosage directed to the primary lesion, also may cause secondary necrosis of soft tissues and bone.

Surgery, with or without preoperative radiation, is proving most effective if the primary lesion and related lymphatic system are removed en bloc. The combined operation includes removal of part of the tongue, floor of the mouth, mandible, and the entire cervical lymphatic system on the involved side; it is known as the "commando" operation. Recent advances in anesthesia, antibiotics and blood replacement have made its wider application practicable. In properly selected cases the surgical risk is slight and the morbidity compares favorably with extensive radiation therapy. Adequate cosmetic and functional rehabilitation can be accomplished by secondary plastic reconstruction if indicated.

Two patients are presented in which a commando operation was employed. The operation consists of three stages: (1) A radical

dissection of the lymph bearing structures on the involved side of the neck, extending from the base of the skull above to the clavicle below, and from the ribbon muscles anteriorly to the trapezius posteriorly. (2) Removal of the horizontal ramus of the mandible and half of the tongue and the floor of the mouth on the involved side in continuity. (3) A tracheotomy to ensure a satisfactory air exchange in the immediate postoperative period. Microscopic sections from the primary lesion, floor of the mouth, and cervical lymphatic system proves the extent of malignant infiltration beyond the apparent confines of the tumor. Postoperative pictures of these patients indicate minimal functional and cosmetic deformity.

Meeting of Monday, March 2, 1953

THE PRESIDENT, DR. LAWRENCE J. LAWSON, IN THE CHAIR

Frequency Localization in the Cochlea as Determined in Experimentally Deafened Cats

HAROLD F. SCHUKNECHT, M.D.

One method of determining the spacial distribution of frequencies along the cochlear duct is to create cochlear lesions in animals and to correlate the resulting functional and pathologic changes. This can be accomplished only if reliable quantitative methods are used to test the hearing and record the cochlear pathology. The most accurate technique yet devised for determining the auditory thresholds of animals is avoidance conditioning. The repeat reliability of this method is about plus or minus five decibels. Spacial orientation of intracochlear pathology can be determined by graphic reconstruction with an error which is probably less than five per cent. Experimental lesions were made in the cochleas of 26 cats after which audiograms and cochlear reconstruction were made. In 16 there were abrupt hearing losses and the cochlear lesions were of limited size. The margins of these lesions were characterized by an abrupt change from abnormal to normal of sensory (or neural) elements. The method used to correlate functional and pathologic changes is indicated in the following example:

Cat No. 1 had a normal auditory threshold for frequencies from 125 to 8000 c.p.s. The frequency 16,000 c.p.c., however, was not heard at an intensity of 65 db above its preoperative threshold. Histologic examination of the cochlea revealed a loss of outer hair cells

and some inner hair cells to the 6.8 mm point (as measured from the basal end), beyond which the cochlea was normal. Thus the margin of the lesion (6.8 mm) appears to be somewhere between the points of maximum excitation for 8000 c.p.s. and 16,000 c.p.s. Twenty such correlations were made from 16 ears. One correlation was made for the frequency range 250-500 c.p.s., two for 500-1000 c.p.s., two for 1000-2000 c.p.s., two for 2000-4000 c.p.s., seven for 4000-8000 c.p.s., five for 8000-16000 c.p.s., and one for 16000-32000 c.p.s. When the mean distances are plotted as a function of frequency we find that the point of maximum excitation for 32,000 c.p.s. is 9 per cent of the distance along the cochlear duct, 16,000 is at 21.3 per cent, 8000 c.p.s. at 33.6 per cent, 4000 c.p.s. at 45.9 per cent, 2000 c.p.s. at 58.2 per cent, 1000 c.p.s. at 70.5 per cent and 500 c.p.s. at 81 per cent.

It should be understood that the orderly arrangement of frequency response along the cochlear duct does not necessarily strengthen the "place" theory of pitch perception. It appears that the fields of excitation are not so sharply localized that pitch perception can be accounted for on this basis alone. It might be well to borrow the terminology of Ruch who referred to cortical excitation in terms of "modal excitation fields" (modal implying only that they are peaked). Thus the cochlear response to a pure tone stimulus does not occur at a point of excitation but in a "modal excitation field."

DISCUSSION

DR. SHERMAN SHAPIRO: Dr. Schuknecht has given a definite anatomic basis for the clinical facts in otosclerosis, in that the conductive impulse does not reach the low tone area, and the hearing for low tones is therefore diminished.

DR. ALFRED LEWY: That does not explain the loss for high tones which also occurs in otosclerosis. Even when the loss is in the low tones there is also some loss in the high registers.

DR. JOHN BALLENGER: I should like to ask if any studies were made of the differential functions of the inner and outer hair cells. In other words, have you instances where only the outer hair cells were destroyed, and what resulting abnormalities were noted?

DR. HAROLD F. SCHUKNECHT (closing): In answer to Dr. Ballenger, let me say that little is known regarding functional differences between inner and outer hair cells. From our own investigations on cats we are able to provide some information on the effect of progressive stages of hair cell injury on auditory thresholds. For stimulus intensities up to 4000 c.p.s., a partial loss of outer hair cells

(within the excitation fields for these frequencies) causes a threshold elevation of less than 50 db; a total loss of outer hair cells in a particular region causes an elevation of about 50 db for the involved frequencies; and a loss of outer (plus some inner) hair cells causes threshold elevations of more than 50 db. Total loss of hair cells results in total deafness for frequencies having their fields of excitation within these regions.

Electrolyte Studies on Meniere's Disease

HENRY B. PERLMAN, M.D.

AND

JAMES M. GOLDINGER, M.D.

Fifteen patients with active Meniere's disease were hospitalized from two to four weeks for a careful study of their sodium, potassium and water metabolism. Both a measured decrease in serum sodium and a measured increase of serum sodium were produced and their effect on the vestibular and cochlear manifestations of this disease were noted.

By severe sodium restriction in the diet (300 mgm daily) the use of 4 to 8 gm of ammonium chloride, 2 cc of thiomerin every other day to prevent sodium conservation of the kidney and occasionally intravenous aminophyllin, a moderate lowering of the serum sodium level was achieved in the first group of patients.

In the second group of patients extra dietary salt was provided in amounts up to 8 gm per day and the retention of this extra salt was brought about by giving these patients varying amounts of desoxycortisterone, a steroid which causes sodium retention probably by affecting more complete sodium reabsorption by the renal tubule. A significant measurable increase in serum sodium concentration was produced.

No consistent effects on cochlear or vestibular function were noted in patients with a measured low serum sodium as random fluctuations in hearing continued and some acute severe attacks of vertigo were observed. No acute attacks of vertigo were seen in patients whose serum sodium had been sharply raised and no consistent deterioration of cochlear function was produced. A number of these patients even had significant and sustained improvement of cochlear function during and following such treatment.

The Kepler water test failed to reveal impaired water diuresis in these patients and no changes in vestibular or cochlear function was noted during the course of the test.

DISCUSSION

Dr. Robert Henner: While my question is not exactly pertinent to this discussion, I should like to ask whether Dr. Lindsay and his group have ever attempted to study electrolytes during destructive labyrinthotomy; or if such studies have been made by other men doing that type of research.

Dr. Henry B. Perlman (closing): We have not made any series of determinations of the sodium potassium and chloride during the acute vestibular disturbances in Meniere's disease. We have, however, had occasion to draw blood in two hospitalized patients at the time they were having acute attacks of vertigo, and found no changes in the electrolytes.

Clinical and Laboratory Observations on Conduction Deafness

Heinrich G. Kobrak, M.D.

For a better understanding of impedance deafness, studies correlating function and morphology are essential. Twenty years ago Polvogt published a series of morphologic-functional examinations in middle ear disease. In our study an important change was made from Polvogt's work at Johns Hopkins University. It was felt that examination of the structural middle ear changes does not have to be on autopsy material. Certain changes can be studied satisfactorily by a method which may be called "biomicroscopy' 'of the middle ear.

This paper attempts to demonstrate the method of ear-biomicroscopy and to outline some of the results. The method consists in enlarged photography of the ear structures in both animals and humans. Photographic recordings cannot only be demonstrated to others for the sake of teaching and discussion, but are helpful for analysis of the pathology and for quantitative measurements.

The enlargement obtained by eardrum cinematography consists of low-power magnification produced by the lens system (object to image ratio was about 1:3), and by projection.

A motion picture is shown to demonstrate clinical otoscopic findings simultaneously with the auditory function. The absolute threshold of hearing was measured by pure tone audiometry.

The first four cases have one feature in common with Polvogt's study. They are clinical cases with considerable otoscopic pathology but still the hearing function is normal within 15 db. One important difference exists with Polvogt autopsy material—there is no time lag between the audiogram and the photographic recording of the morphology. In half of Polvogt's patients there was an interval of three months between the hearing test and the date of autopsy. On our material the hearing test was performed within a few minutes after the cinematographic recording.

It is evident that a considerable amount of structural changes in the pars tensa may occur without changing the function. A retraction or even a synechial connection with the promontory can be found with good function remaining. A small amount of fluid in the hypotympanum above the window level is still compatible with nearly normal hearing. A glomus tumor is demonstrated in which the growth was confined to the hypotympanum. A hearing loss of about 10 to 15 db was observed.

The second part of the demonstration consists of case presentations in which the morphologic changes are contrasted with the audiometrically measured hearing losses. A classification of various types of impedance deafness is given.

Meeting of Monday, April 6, 1953

THE PRESIDENT, DR. LAWRENCE J. LAWSON, IN THE CHAIR

Cardiac Arrest

E. H. FELLS, M.D.

AND

LOWELL F. PETERSON, M.D. (by invitation)

A motion picture was shown.

DISCUSSION

DR. THOMAS C. GALLOWAY: This film has taken away some of the mystery in this condition of cardiac arrest, which has been thought of as something peculiar that happens in rare instances, a condition for which nobody can be blamed and for which there is no particular explanation. However, the explanation may be rather simple. A heart that responds to a severe vagus effect, if it is a nor-

mal heart, will usually escape after a period of slowing and even temporary arrest. But a heart that has been damaged by anonoxia, by myocarditis, by previous infection, may not do so. After all, cardiac arrest occurs because there is some fault, usually with the anesthetic, or in the position which permits collapse of the trachea, or inattention to breathing, to an unclear airway, and especially to that condition which needs to be emphasized, spasm of the vocal cords. Coryllos showed that spasm may produce asphyxial death in submergence, even without flooding of the lungs. Spasm may be due to instrumentation and, especially in the presence of sodium pentathol, it may occur when the instrument is withdrawn from the trachea. As laryngologists, we must teach anesthetists that the airway must be clear at all times, that even a few seconds of anoxia is dangerous, and that between three to five minutes of anoxia may result in death. Coryllos showed that in the third phase of respiratory asphyxia, which comes in the third minute, there is a period of only 10 to 15 seconds when it may be possible to resuscitate the animal.

We hope that none of us will ever have to undertake these heroic measures. I do not think we would know what to do or be able to do it. But I think it is important to reemphasize the need for avoidance of anoxia. There may be some cases which occur with manipulation within the mediastinum, with certain reflex mechanisms, but usually the condition will result only when proper attention has not been given to maintenance of a clear airway.

The expression "massage of the heart" is used a great deal. I would like to ask how much of this is active stimulation of the musculature and how much is due to substitution of manual pump pressure to make the heart reestablish its function as a pump and circulate the blood to both the heart muscle and the brain. It is to be borne in mind that the heart muscle is much less vulnerable than the nervous tissue. The limit of recovery of the brain is probably three, five, or at most, eight minutes. The heart muscle apparently under some circumstances may have a considerably longer period of recovery, so whatever may cause cardiac arrest, the attention still should be focused on the central nervous system damage.

DR. LOWELL F. PETERSON (closing): The accident of cardiac arrest was almost unheard of in the days of ether anesthesia, or else was rarely diagnosed. These days it has to do with the so-called balanced anesthesia, wherein we have a little of this and a little of that —cyclopropane, nitrous oxide, a little pentathol, a little ether, a little curare—which produces such a complicated picture that the heart fails to respond in a normal manner.

It has been mentioned that atrophine is a very good "protecting drug," particularly in long surgical procedures, and in such instances it is no doubt of considerable value. I should say that adequate administration of oxygen and maintenance of an open airway is most important.

Cardiac massage is not a trick procedure by any means, and I would urge you to go to your medical institutions and procure a dog to demonstrate the procedure. Produce cardiac arrest and then massage the heart. It is comparatively simple if you do not have to do it more than three or four minutes, because after three or four minutes of cardiac compression you will be exhausted. From my own experience I would say that the most important thing is actual compression of the cardiac musculature; whether it is muscle stimulation per se or whether it is oxygenation I am not in a position to say. But these hearts do go on to recovery if the anoxia has not extended beyond three to five minutes.

The Metabolism of Fresh, Transplanted and Preserved Cartilage

DANIEL M. LASKIN, D.D.S., M.S.

AND

BERNARD G. SARNAT, M.D.

Manometric analysis of carbohydrate metabolism (respiration and anaerobic glycolysis) of tissues in the Warburg respirometer offers a dynamic approach to the problem of cellular viability. These processes were studied in fresh rabbit costal cartilage autografts and homografts, and in frozen-dried and merthosaline preserved homocartilage after implantation subcutaneously in the abdominal wall of recipient animals for as long as 150 days. The metabolic activity of these tissues was compared with that of fresh rabbit costal cartilage, autoclaved fresh cartilage, and with non-transplanted cartilage preserved (frozen-dried or merthosaline) for periods of seven days to three months. All specimens, whether for implantation or preservation, were utilized devoid of perichondrium.

The rate of respiration and anaerobic glycolysis of fresh costal cartilage was found to be among the lowest of all tissues. Carbohydrate metabolism was predominately anaerobic. Both the autografts and homografts showed approximately a 45 per cent decline in respiration and anaerobic glycolysis during the first seven days following transplantation. After this initial decline no further sig-

nificant variations occurred in either group. The metabolic rate of the frozen-dried and merthosaline preserved cartilage approached zero after three months of storage. Following implantation these specimens showed no change in carbohydrate metabolism.

These investigations indicated that in the rabbit fresh costal cartilage autografts and homografts remained viable for as long as 150 days after implantation. They also showed that a difference existed between the state of viability of these grafts and fresh costal cartilage. This has not been demonstrated by ordinary histologic methods. The low, predominately anaerobic metabolism of cartilage probably contributes to its ability to survive transplantation. The preserved and autoclaved cartilage, as might be expected, were non-vital.

DISCUSSION

DR. OSCAR J. BECKER: Surgeons are primarily interested in the use of cartilage for grafting purposes and many phases of the problem are clarified by this presentation. From the studies presented, it appears that both fresh autogenous and fresh homogenous rabbit cartilage are definitely living grafts after transplantation. This further substantiates the evidence found by histologic methods and by our own clinical experience. As has been emphasized, preserved cartilage when transplanted is a dead graft or implant from a metabolic standpoint. Autoclaving and probably boiling of autogenous cartilage will also result in a dead graft.

From the experiments of Drs. Laskin and Sarnat, by the use of metabolic activity measurements, there apparently is not much difference in the frozen dried method or the merthosaline method; both methods will destroy the viability of the chondrocytes. However, what happens to the cartilage matrix? Is there more of a chemical reaction and change by the merthosaline method than by the dry freeze method? These questions must have puzzled the authors as well, since they stated that further investigation was necessary before a comparative evaluation was made. At present, the fate of preserved cartilage is extremely variable, some absorbing completely within one or two years and others retaining their shape indefinitely. Naturally, many factors enter into the problem besides the method of preservation.

Perhaps the frozen dried method will prove superior to the merthosaline method for preserving the chemical composition of the cartilaginous matrix. Experiments to justify this conclusion have recently been published by the U.S. Navy Tissue Bank at Bethesda,

in a preliminary report. In my own experience I have seen preserved cartilage implants retain their shape and character in the nose for periods up to nine years, with histologic evidence of the survival of the cartilage matrix, but with dead chondrocytes. Whether or not there is any metabolic activity between the mesenchymal fibroblasts which may have undergone metaplasia in the surrounding tissues or perhaps from the surrounding perichondrium or periosteum, is purely hypothetical. Perhaps because of the low metabolic activity needed to maintain the cartilaginous matrix, plus the low homotoxic reaction elicited by cartilage, as indicated by Loeb in his work on tissue and individual differentials, the surrounding tissues by forming a fibrous capsule around the implant may subserve the function of the chondrocytes.

The age of the donor of the preserved cartilage is another factor in the persistence of the implant. If young adult rib cartilage is used, the amount of chondroitin acid sulfate present in the matrix may make it resistant to infection and absorption. As we know, in older individuals, the acid pH is lowered due to loss of chondroiten sulfate. The lowered pH allows the enzyme alkaline phosphatase to prepare the cartilage for ossification by absorption. The importance of these chemical constituents is to be noted clinically by the more rapid absorption of transplanted cartilage from an older individual. (Septal cartilage, because of its high content of chondroitin sulfate, is perhaps a better grafting material). These conclusions are somewhat substantiated by observations made in transplanting epiphyseal cartilage. This cartilage has a high content of alkaline phosphatase, since it is destined to undergo endochondral ossification and, therefore, clinically shows a high rate of absorption. Other factors, such as the recipient site, the amount of surrounding scar tissue, tension or strain on the implant, an infected field, and whether placed in contact with bone or cartilage, or imbedded in fat or muscle, as well as the size of the implant, are important considerations.

DR. SAMUEL SALINGER: These investigations have confirmed what we have always assumed, namely, that freshly implanted cartilage would preserve its viability. I have always felt that the process of boiling cartilage, which destroys its viability, renders it no more agreeable than preserved cartilage. As clinicians, we are extremely interested in the reasons why certain transplants will persist over an indefinite period of years, while others will absorb, and I think possibly future investigations along the line of the present one may shed some light on that subject.

DR. DANIEL M. LARKIN (closing): I am in agreement with Dr. Becker that the state of the cartilage matrix is probably an ex-

tremely important factor in determining the persistence of preserved homocartilage implants. Because of its character, resorption of cartilage is at best a relatively slow process. Whether resorption will occur depends in part upon the immunologic response of the host. It would appear from both clinical and experimental studies that the antigenicity of homocartilage is more closely related to the metabolism of vital chondrocytes than to the foreign protein of the matrix. Thus, it may be stated paradoxically that in a preserved homocartilage implant, perhaps it is the absence of viable cartilage cells which contributes to its acceptance by the host.

Dr. Becker is correct in saying that rapid freezing and dehydation should prove to be superior to refrigeration in merthosaline for preserving the chemical composition of cartilage. On the other hand it is possible that preservation in merthosaline may so change the tissue as to reduce its antigenic properties. There must be further investigation and clinical trial before a more accurate comparison of the two methods can be made.

Experiences with Fenestration Surgery

FRANK WOJNIAK, M.D.

Fourteen years have elapsed since Lempert's monumental report on his first 100-odd patients with otosclerosis operated upon by his one-stage endaural fenestration technique. Many thousands of fenestrations have been performed to date but, owing to the technical difficulties of the procedure, the vast bulk of these operations have of necessity gravitated into the hands of a very few. Yet, encouraged by Lempert's emphatic assertion that the fenestration is not a one-man operation, there are bound to be many so-called occasional operators.

This is a discussion of some of the unique problems which confront an occasional operator, and a report is being made of 126 fenestration operations performed during a period of seven years. Eighty-seven patients have been rehabilitated for all practical social and economic situations to the entire satisfaction of both the patient and those who come in close contact with him. In 35 patients there was either no gain in hearing, or the gain was not sufficient for adequate rehabilitation. Four patients have been made worse by the operation.

While fenestration surgery in its various phases may offer many difficulties, it presents a challenge which should be met by more otologists.

DISCUSSION

DR. GEORGE E. SHAMBAUGH, JR.: Dr. Wojniak is to be complimented on his very good results and also on the faithful recording of his bad results along with the good ones. I think it is noteworthy that in his series closures have been relatively few, and we can say that the problem of osteogenic closure which used to be the chief problem of the operation has receded greatly in importance.

I should like to mention a new development in the fenestration operation which has to do with the mechanics of the fenestrated ear. When sound enters the normal ear it tends to enter the labyrinth through the round window as well as the oval window. The impedance-matching mechanism of the large tympanic membrane, the ossicular chain and small oval window, causes a marked differential in sound pressure at the two windows so that this results in good mobility of the intra-labyrinthine fluids. After fenestration, sound again tends to enter both windows, but in the absence of an impedance-matching mechanism there is less of a differential in sound pressure at the fenestra compared to the round window, therefore a successful fenestration operation leaves a deficit of 25 decibels of conductive loss. The differential between the two windows may be increased by applying a thick layer of ointment onto the tympanic membrane obstructing the passage of sound to the round window. Following the suggestion of Kobrak, we have been using aquaphor ointment for this purpose. Not every patient can be helped by this simple prosthesis, but more than half the cases where it has been tried have shown a substantial gain of 5 to 10 decibels for the speech frequencies. This, added to the gain already obtained from fenestration, results in a very gratifying level of hearing.

DR. ROBERT HENNER: When one thinks back to the days when there was no treatment for otosclerosis, I think that Dr. Wojniak, in his modest interpretation of his results, has played down the whole situation to the extent that one gets a conservative viewpoint. Comment should be made in the light of his conclusions rather than on his presentation of the body of his paper.

Lempert and others have pointed out that the clinical diagnosis of otosclerosis cannot be made perfectly. When we diagnose a case it is clinical otosclerosis and not otosclerosis from a histologic viewpoint. When the tube is patent, the drum is clear, and there is definite conduction deafness, we presume that it is a case of otosclerosis, and until we have microscopic evidence we have no way of contradicting that diagnosis. As to Schwartz's sign being typical of otosclerosis, I would rather not see it in a patient on which operation

is contemplated. It is invariably a sign of associated nerve deafness in a progressive stage.

I do not consider a soundproof room essential for most patients sufficiently handicapped to consider surgery. Dr. Wojniak's selection of cases is essentially what Dr. Shambaugh has pointed out as Class A cases, and if one can limit himself to those his percentage of good results will undoubtely be higher. The gratification that comes from doing an occasional case in the group in which the predicted results are poor, and obtaining an unexpected good result, is worth while.

In my Army experience I had occasion to study patients with individual susceptibility factors toward the development of deafness. Cases of preclinical otosclerosis, those patients with 25 to 30 decibel loss, and normal bone conduction, were susceptible to airplane noise. I could predict that there would be a loss of hearing in the course of their flying training. I think patients who lose hearing subsequent to a successful fenestration operation often do so through acoustic trauma in their occupation. Following fenestration procedures, I have been protecting patients who are exposed to unusually loud noises with some type of defender. At Hines Veterans' Administration Hospital, the Eye Department has developed the use of a product called "elastomer," a plastic that is ordinarily used to protect telephone wire. It can be blended in color with the skin, it is soft and pliable, and is not affected by soap and water or other cleaning agents, nor by temperature. It defends 15-20 decibels in all frequencies except 2000 and 4000, where it defends 30-35 decibels. This is an unusually protective range for any defender.

Dr. Frank Wojniak (closing): The discussions of Drs. Shambaugh and Henner are gratifying to me. In connection with Dr. Henner's statement regarding the Schwartz sign, I have noted that even though the patient appears to be an ideal subject for a fenestration operation if this sign is present the results are frequently not so good. It seems that probably the case is malignant or in a very active stage, and that is why the Schwartz sign is so well demonstrated. Probably I do select primarily Class A cases more than do Dr. Henner or Dr. Shambaugh. I feel that the occasional operator cannot afford to take the chances they may be able to take. I believe it is unscientific to assume that nihilistic attitude toward even an empirical method, be it a drug or a surgical procedure, as long as that procedure works in alleviating human misery ever so little. I am thoroughly convinced that the fenestration operation works.

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

Meeting of Monday, November 2, 1953

THE PRESIDENT, DR. ROLAND RUSSELL, IN THE CHAIR

Surgical Treatment of Mucoceles of the Frontal Sinus and Existing Complications

MARVIN J. TAMARI, M.D.

AND

STANLEY H. BEAR, M.D.

The surgical treatment of mucocele of the frontal sinus usually falls into one of three categories: (1) diagnostic exploration, (2) removal of the mucocele and establishment of a patent nasofrontal duct and, (3) the management of existing complications found at operation.

Less than 50 per cent of the diagnoses are confirmed by both x-ray and clinical findings. Many cases must be handled on an exploratory basis in order to establish the diagnosis and indicated treatment. Even with the classical signs of downward, forward and lateral displacement of the eyeball or an associated diplopia, a presumptive diagnosis is all that can be made unless there is definite evidence of bony break-through. We feel that open exploration with frozen section microscopic examination is the best method of obtaining a correct diagnosis.

In two recent cases a diagnosis of a mucocele of the frontal sinus was made by x-ray and clinical examination, but on surgical exploration no mucocele was found. Stuart and McNally have reported similar experiences.

The etiological factors must be considered before surgery is undertaken. Many theories have been advanced, traumatic, inflammatory, cystic degeneration, polypoid degeneration of the turbinates, allergic, congenital and tumorous. In the majority of cases we feel that no one factor is responsible, but that there is usually a combination of conditions. A number of cases with a history of trauma followed by an inflammatory or allergic condition of the nose and sinuses

have developed a mucocele. In some instances a tumor of the frontal ethmoidal region has been the causative factor. When an inflammatory condition exists, definite measures should be undertaken to correct this before proceeding with surgical removal of the mucocele. Such measures include sensitivity studies, antibiotic and chemotherapy, sinus and nasal irrigation, and medications for nasal shrinkage. In some cases it may be necessary to infract the middle turbinate in order to establish drainage. An allergic condition, if present, should be brought under control insofar as is possible. Allergic desensitization, the use of antihistaminic drugs, and surgical removal of polyps blocking the nasofrontal duct should be carried out.

In the surgical removal of a mucocele, the two main objectives are (1) to remove completely the mucocele sac and its contents and, (2) to establish a permanent patent nasofrontal duct. There are different operative approaches; the intranasal, the radical external with or without a rubber drain, or the external with intranasal surgical procedures. We prefer the external frontal approach (either Lynch, Killian or Riedel) with a rubber catheter or acrylic tube placed in the nasofrontal duct.

The most satisfactory approach is the eyebrow incision advocated by Lederer. After reflection of the periosteum one should determine if there is any bone erosion. With gouge and mallet the frontal sinus is opened and the extent of the mucocele explored, and pathologic bone is removed. With a curette or blunt Freer instrument one should try to separate the mucocele and the contents intact from the bone and adherent structures (which is almost impossible). When the mucocele is evacuated a probe is introduced into the nose. Often it is necessary to remove the bone from the floor of the frontal sinus, as well as the anterior ethmoidal cells, in order to enlarge the introitus of the nasofrontal duct. At this stage a modified frontal cannula, with a heavy silk thread through an eyelet at the tip, is inserted through the nasofrontal duct. To accomplish this it may be necessary to remove the tip of the middle turbinate. A catheter (6 to 9 mm) is inserted from above and secured, with one end of the black silk suture threaded through the eyelet of the frontal cannula. The tip of the cannula is inserted into the lower opening of the catheter, and both the cannula and the catheter are withdrawn until the catheter protrudes from the nasal orifice. The end of the catheter is sutured to the skin of the vestibule of the nose after the cannula and thread are removed. The catheter is then checked for patency. The periosteum and soft tissues are closed with chromic catgut sutures, and the eyebrow incision is closed with No. 3-0 interrupted black silk sutures. Postoperatively, careful check

should be made to see that the catheter remains patent. Routine irrigations are not performed, but if the tube becomes obstructed a soft, sterile metal probe can be gently passed into the tube.

The catheter is maintained in place for four to six weeks, which is usually sufficient to prevent cicatrization of the nasofrontal duct. When it is removed the duct will remain patent.

The radical external frontal approach is preferred because (1) it allows complete removal of pathologic bone; (2) it provides direct visualization, thereby favoring complete removal of the cyst: (3) it offers the best opportunity to detect evidence of existing pathologic changes: (4) the inferior wall of the frontal sinus can be more adequately removed and, (5) the catheter can be more easily inserted into position in the duct.

There may be associated serious complications, such as erosion of the posterior wall of the sinus with exposure of the dura and, on occasion, the sac may be adherent to the dura. Treatment consists of removal, when possible, of the complete sac covering the dura and removal of the diseased bone, allowing the dura to remain exposed. Erosion into the orbit may be present, with destruction of extraocular muscle attachment especially in the area of the pulley of the superior oblique muscle. Surgical correction consists of complete removal of the mucocele sac and attaching the muscle pulley to adjacent periosteum or the orbicularis oculi muscle. Retro-ocular extension may produce proptosis of the orbital content. Treatment consists of complete removal of the mucocele and its contents from the retro-ocular area, with care not to disturb the optic nerve or blood supply to the eyeball. Proptosis usually subsides after removal of the cyst. Should osteomyelitis of the frontal bone be present, the infected bony areas, plus at least one centimeter of the normal-appearing bone edges, should be removed.

DISCUSSION

DR. JACK ALLEN WEISS: That surgery of the frontal sinus is still a problem is evidenced by the considerable literature on the subject, much of which is controversial. Operative procedure for mucocele is one facet of surgery of the frontal sinus, with the important factor that one rarely has to contend with infection of either mucosa or bone. Still the outcome is not always satisfactory. In Goodale's statistics there were four recurrences in 18 cases. Disappointingly enough, recurrence may be delayed for many years.

The question of external versus intranasal approach has been largely resolved in favor of the former. Even Goodyear, who ad-

vocated the intranasal route, stated that it is limited to selected cases. The question as to how to maintain the nasofrontal connection has no universally accepted answer. I purposely do not say nasofrontal duct, because there is no longer such a structure after anterior ethmoidectomy is done; removal of the agger and infundibular cells destroys the duct.

The question of removal of the sinus mucosa is open to discussion. The membrane is usually not infected. Also it is not proliferative, if we dismiss the concept of the degenerated cyst as an infrequent occurrence and adhere to the explanation of duct obstruction as the major factor in the pathogenesis. Microscopic examination shows pressure changes such as altered epithelium, atrophic glands and little or no inflammation. The reason for removing it is not apparent to me. I have usually left it in situ, without jeopardizing the outcome. Where there is a defect in the sinus wall and the presenting mucosa is hypertrophied, that portion should be removed. Even mucosa covering a bony defect over the dura should be left in place in the absence of signs of intracranial involvement.

The fact that many methods are used in the effort to maintain an opening is evidence that this is not always successfully accomplished. Leaving the duct intact invites recurrence. The use of free transplants of skin or mucosa has been successful. Mucoperiosteal flaps have succeeded. Others advocate the use of obturators such as polyethylene or rubber tubing, plastics, gold or inert metals, such as tantalum or vitallium. The persistence of the nasofrontal opening depends greatly on the relation of the ethmoid to the frontal sinus and also on an opening through the ethmoid. The duct itself is about 3 mm in diameter, encircled by ethmoid cells in part. The ethmoid labyrinth has a width of 5 to 15 mm in extent. As Weille has indicated, if there is a large ethmofrontal cell in relation to the frontal sinus, exenteration of the anterior ethmoid allows an excellent opening into the nose.

I recently operated upon an ethmofrontal mucocele adjacent to an orbit from which the eye had previously been removed. After an external approach there was found resorption of the entire floor of the anterior ethmoid complex. Incising the mucous membrane in this "Nature done" operation afforded a large opening, which I am reasonably sure will remain. There will be a subsequent report of this case.

Consideration should be given at the time of the original operation to possible need for plastic reconstruction, and this might include taking of a pattern or a mold of any existing defect.

DR. MARVIN J. TAMARI (closing): Our paper deals only with the surgical approach and not with the etiology of the mucocele. From our experience we do not believe it possible to leave the membrane in and obtain a good result from surgery. Pathologically there is no membrane remaining and if there are clinical symptoms of a mucocele the cyst fills the sinus almost entirely, and no membrane of the original cavity is left. What is really found in the sinus is the wall of the cyst, not the mucosa. If the bony wall is destroyed, destruction is pathologic and there is always an inflammatory process. It would be very easy to leave the cyst wall without extensive surgery, but the fact remains that radical operation must be done to prevent recurrence.

Leverage Suspension Laryngoscopy

ROBERT LEWY, M.D.

AND

ARTHUR L. RATKO, M.D.

Personal experience with the standard Jackson method of head-holding positioning, and the instruments used without leverage often posed a problem. Frequently I was neither strong enough or perhaps skillful enough to expose the anterior commissure without great difficulty or the occasional necessity of a general anesthetic or its equivalent. For some years I presumed that this was a personal difficulty and let it go at that. Finally, mustering some courage, I began to inquire among my colleagues and drew some cold comfort from the fact that many of them faced the same problem.

A fresh approach to the problem was started when one of our residents at Hines Veterans Hospital made a copy of the window casement opener that Lt. Col. Somers presented in the April, 1952, Archives of Otolaryngology. This was a home-made imitation of the Andrews detachable laryngoscope holder. It possessed, however, a striking difference. There was immense power (which Somers did not describe) from the gear system of the casement opener. This was a combined sprocket and worm gear. There were large gear teeth that moved easily and rapidly. These could not slip since they integrated a vertical gear system into an almost horizontal groove system in the worm. Using this as the most essential factor of the Somers instrument, the power gear was made the center of a detachable instrument with a strong, easily used three-point grip which grasped the laryngoscope. Also, another instrument bar was put

on the Lynch apparatus. With this modification, the gallows and the table clamp were dispensed with, the laryngoscope holder being substituted in their place.

We have found that the gear power acting as a lever lifts the tip of the laryngoscope and exposes the anterior commissure easily. We have done this repeatedly and thus far without failure. The necessary exposure is gained and two hands and a balanced body position are available for biopsy, polyp or fibroma removal, papilloma removal or whatever the circumstances may require.

Contrary to the orthodox teaching under which we have all been raised we found no difficulty in performing laryngoscopy with the head extended and on the table, as the film will show. This made it possible to dispense with both human and mechanical head holders. I shall show an x-ray film that shows a patient thus positioned. The mouth and larynx are in a direct line, the neck is extended and the laryngoscope clears the cervical spine easily.

In this motion picture, a non-standard position for direct laryngoscopy is demonstrated, and a leverage system of power which is attachable to standard laryngoscopes is illustrated. Neither of these is entirely new. The instrument in particular is a lineal descendent of the laryngoscope of Seiffert as subsequently modified by Roberts, Andrews and Somers and contains some of the strongest and simplest characters of each.

DISCUSSION

DR. A. H. ANDREWS, JR.: I think Dr. Lewy and I disagree slightly in principle on the matter of laryngoscopy. I have felt and taught, as I had been taught in turn, that the important maneuver in laryngoscopy was the lift, not the pry; that the lift applied on the horizontal part of the arm gave adequate exposure. For that reason I viewed Roberts' instrument with concern when I saw it first. He spoke so highly of it that I decided to use it and put together an apparatus that would fit on any of the Jackson laryngoscopes, including the child's size. I found it definitely helpful, but not a complete means of successful laryngoscopy, still feeling that the lift is the important thing and not the pry, that leverage has its place but is not the primary factor. I have felt that the additional support given by the laryngoscope chest support is of definite advantage. I have regarded it as an accessory rather than the principal element.

In using a laryngoscope I frequently pass it at an angle; this gives the extra hand for holding, for example, a vocal cord in po-

sition, passing it sometimes from one side of the mouth, sometimes from the other. Under those circumstances the part resting on the chest may not be in the center; it may be over on the side. In a small child, for example, in removal of a nodule or papilloma, it may even rest below the pelvis. For that reason I have thought that a more flexible type of support on the chest was indicated.

I should like to disagree with Dr. Lewy on his statement regarding unorthodox position of the head. I think he is using the orthodox position; that is, extension of the head on the neck. In the so-called head-high position, the neck is flexed on the chest but the head is extended on the neck. In the head-low position, as he pointed out, the head is still extended on the neck but the neck is hyperextended. I think we differ here on the position of the neck rather than that of the head. No one position of the head and neck is suitable for all cases. It is my custom, when an unsatisfactory exposure is obtained in the head-high position, to try different positions until I find one which most closely fulfills the requirements of the individual case. In the head-high position, if the neck is not completely flexed on the chest, the chin and forehead are still horizontal, and this results in the head not being extended on the neck. This explains the failure of that position when the head is not completely raised to a point at which the neck is completely flexed on the chest.

I wish to compliment Dr. Lewy on the mechanical construction of this instrument. He has shown considerable ingenuity, the construction of the gears is excellent, and I like it much better than Dr. Roberts' original instrument, which I copied. I think there is a distinct improvement in the action of the gears. I would like to point out that the gear ratio in the original Roberts' instrument, and in my instrument, is about 1 to 60, and the gear ratio in his instrument appears to be about 1 to 5. So that actually the leverage obtainable in the first instruments is much higher. That is the reason a small handle was used. When the gear ratio was lower a larger handle was used and I understand that in Dr. Lewy's latest instrument he is using a handle that is a little larger.

I think the matter of quick release is important. By the simple twist of a knob the instrument is completely released from the chest. This makes possible the introduction with the chest support extended, put down quickly and locked, and screwed down. I have thought this was a distinct advantage. However, Dr. Roberts has eliminated that from his instrument, so maybe it is not as important as we have thought.

DR. NORMAN LESHIN: We had the opportunity of using this instrument during the various stages of development. We found this not only a very efficient way to expose the larynx, but a simple one especially for someone who does not use endoscopic procedures often. It is regrettable that Dr. Lewy did not show the exposure of the larynx, because there is a beautiful picture of the entire larynx, and if one wishes to change from the laryngoscope to the anterior commissure instrument it can be done in a few moments. With adequate preparation we have found it probably the finest addition to our armamentarium, for anyone who wants to do some work on the vocal cords with two hands free, and with very little assistance.

DR. SAMUEL J. PEARLMAN: As Dr. Leshin stated, Dr. Lewy was kind enough during the developmental stages to bring this instrument to our attention. We have been able to use it at Michael Reese Hospital and at Cook County Hospital, so that I have had some little experience with it.

Strangely enough, I think the most practical instrument for many years was not the Seifert, but the Haslinger, which was not mentioned tonight. The Haslinger self-retaining instrument has been used satisfactorily, at least in my hands, for a good many years, but there was a complaint against it; the gears were delicate, and a heavy-necked, powerful individual could, after the instrument was in place, close it by simply closing his mouth. That is not at all possible in this model. I would say that with proper preparation—and by that we mean a good deal of topical anesthesia and a considerable amount of demarol and morphine—this instrument works as well in our hands as any we have seen to date.

DR. PAUL H. HOLINGER: Possibly I should not discuss this instrument because I have not used it, but we prefer techniques that consider the laryngoscope an atraumatic speculum for exposure of the larynx. The larynx and pharynx are delicate stuctures and if it becomes necessary to use a worm drive and a gear shift to expose the larynx then possibly there is something wrong with the position of the patient.

Possibly, there are two features to this discussion; one, position, and the other, the instrument itself. So far as position is concerned I agree with Dr. Andrews that often the position must vary, depending upon the patient and his general pharyngeal configuration; so the position shown may be of value in occasional cases. But the patients shown in the motion picture were edentulous and almost any position would still permit laryngeal exposure. However, for good visualization of the anterior commissure in the position that was

used, one would probably have to *have* a worm drive and a gear shift in order to expose the larynx at all. Simply lifting the occiput would have put the larynx in a direct line with the pharynx with easy exposure that would avoid the necessity of "leverage laryngoscopy."

So far as being able to use two hands is concerned, one could quote the baseball adage, "Two hands for beginners." But I know Dr. Lewy is not a beginner, so I wonder if after he has the laryngoscope inserted, the worm drive driven and the chest support supported, he is ever tempted to stand back and say, "Look, no hands."

DR. ROBERT LEWY (closing): I agree that the positions vary, and we settled upon this position in an extremely difficult case and, since it worked in a difficult case, we continued to use it for standard cases. I have no quarrel with any technique which is satisfactory in someone else's hands. I can only say that with my own hands and without gear power I was frequently in a very difficult position when it came to exposing the anterior commissure; the amount of strength required on occasion was such that my body was often tense and I was unable to do surgery in the relaxed manner which I think is necessary. I remember very well the case of a doctor in whom I could not expose the anterior commissure. We finally used general anesthesia and exposed the anterior commissure, thus accomplishing our purpose. I feel sure that had we had the gear power we would have succeeded in doing so without the need for general anesthesia.

I have used the Haslinger instrument only once or twice. I never succeeded in using it to my satisfaction and dispensed with it early in my career. Recent re-examination of the instrument points to its delicacy.

As indicated by Dr. Pearlman, a problem which is most important is that of proper preparation, and I consider this cannot be over-emphasized.

I do not think there is much difference of opinion between Dr. Andrews and myself. I will say that his instrument will fasten on a child's laryngoscope and mine will not. This shortcoming I hope to correct and have the handle of the child's laryngoscope modified so that it will accommodate the detachable holder as well. The gear ratio in this instrument seems to be extremely satisfactory. The gears are large and cannot slip. The quick release, to me, was a complexity which we could get along much better without.

I think the instrument does lift the tip of the laryngoscope, which is the essential place for the lift to occur, and of course at the beginning of the operation we work with standard lifting by hand

power. We have done this with many dentulous as well as edentulous patients; our x-ray indicated this. More of them have had teeth than have not. The teeth that are rested against are usually carefully protected with rubber tooth protectors, and the instrument rotates at that point; the pressure has not proved too great with this protection.

Differential Diagnosis of Vertigo

M. M. Hipskind, M.D.

For more than 100 years Meniere's name has been attached to those cases having vertigo as one of their main symptoms. Over this time various terms have been used: Meniere's disease, Meniere's syndrome, Meniere's symptom complex, pseudo-Meniere's disease, etc. In the film presented, it is our purpose to approach the problem of vertigo in terms of anatomic-pathologic conditions. For clinical purposes we have divided our cases into two types according to the positional nystagmus. According to Nylen's classification of positional nystagmus, it may be divided into Type I, in which direction of the nystagmus changes with different positions of the head. It may be irregular in its appearance or it may reverse; Type II, the direction is constant but the intensity varies with change of position or is present only in certain positions. Type I is probably indicative of a central nervous system lesion, whereas Type II may occur with either a peripheral or a central lesion. The film demonstrates the procedure we routinely follow in the examination of these cases.

DISCUSSION

Dr. John R. Lindsay: Dr. Hipskind is to be congratulated on this film, the crowning point of which I think is the visual demonstration of positional nystagmus. He has shown clearly that in patients who have what we call postural vertigo, the examination customarily done with the patient sitting in a chair or lying on a table, might show no objective evidence that would support the patient's claim of being dizzy; whereas if one takes the trouble to ask a few direct questions, the history of postural vertigo can be brought out very clearly. Then, if one takes the trouble to go through a simple routine of postural tests, clearcut evidence can be obtained.

I might discuss the film briefly. First of all, in the operative procedure shown in the case of hydrops, I must disclaim any originality about that operation; that is, as you know, Cawthorne's operation in which he removes the membranous labyrinth from the hori-

zontal canal. I have had failures with that operation, as I have had failures with the Day procedure in using the cautery, and I think a better procedure than either one is to do a more radical operation, simply make a bigger hole in the vestibule, open the ampulla of both the horizontal and the superior vertical canals, and then instrumentally destroy the contents of the vestibule. I do not see any point in using the cautery because I think it adds an additional factor of risk which is unnecesary.

One or two points about patients with postural vertigo: The essential point is the necessity to ask specific questions to bring out any postural character and to look for objective evidence by doing postural tests. We have tried to determine whether we could localize the origin of the vertigo to the central vestibular apparatus or to the periphery. I do not think that is really too important practically. In most cases it does not matter whether it is peripheral or central. If one can rule out signs or symptoms of central nervous system disease that might be progressive, one can be relatively sure that the prognosis is good. We cannot say how long it will be before the patient recovers, because it may be weeks or months or even longer, but the important point is that a good prognosis may be given if evidence of other progressive disease can be ruled out.

The chief contribution of this film is, I believe, the clear visual demonstration of a positional nystagmus. You can see that it is a very real phenomenon. In the past I am quite sure that many patients, just because no objective evidence could be demonstrated to support their claim of vertigo, have been dismissed with the opinion that it was merely a psychogenic disturbance without any organic disease. It is a great mistake to make such a diagnosis without first going into the possibility of a postural vertigo.

Dr. M. M. Hipskind (closing): I may be in error, but it was my impression that the Cawthorne operation removed the posterior bony auditory canal wall. I took the liberty of putting my teacher's name on the operation demonstrated in this film inasmuch as he was the only one to my knowledge at that time to approach the horizontal canal through a simple mastoidectomy technique. For once in my life, I have the pleasure of disagreeing with Dr. Lindsay. I put particular emphasis upon the differentiation of the type of nystagmus. An effort is made to determine its basis, whether central or peripheral. I do this because I have seen several cases of exudative middle ear catarrh with associated vertigo and of toxic neuritis with associated vertigo. All these patients had been on a salt-free and restricted fluid diet. One patient with a labyrinthine fistula had

been on a salt-free diet. Since restriction of salt and fluid would not benefit these cases I feel it is an injustice to place them on such a diet. In my opinion, in cases of vertigo that can clinically be identified to be on a peripheral basis, we need not have dietary restriction. That would not include labyrinthine hydrops which in the present concept does indicate restriction of salt and distribution of fluids.

Announcement

THE SIXTH INTERNATIONAL CONGRESS OF OTOLARYNGOLOGY

The Sixth International Congress of Otolaryngology will be held in the United States of America in the Summer of 1957. The exact dates and the place of meeting are, at this writing, still undecided. It will be the first International Otolaryngological Congress to be held outside Europe, and will afford a welcome opportunity to American otolaryngologists to meet and exchange views with their colleagues from all over the world.

The first of the present series of Congresses met in Copenhagen in 1928 under the presidency of Prof. Schmiegelow; it was attended by 600 members representing 41 countries. The second was held four years later in Madrid, under the presidency of Prof. Tapia; the third in Berlin in 1936, under the presidency of Prof. von Eicken.

At the meeting in Berlin, Holland was designated to take the Congress in 1940 and England, tentatively, in 1944. However the war intervened, the Berlin records were lost, and further plans remained in abeyance until 1947. At that time, the Dutch committee having indicated its temporary inability to undertake a meeting, the British Association of Otolaryngologists agreed to be hosts to the Fourth Congress. This took place in London in 1949 under the presidency of Mr. V. E. Negus, and was attended by some 1300 members from 45 countries. The Dutch then resumed their obligation and the Fifth Congress was held in Amsterdam, in June 1953, Prof. Eelco Huizinga presiding. The Sixth, to be held in this country in 1957, will be under the presidency of Dr. Arthur Proetz.

Official recognition and sponsorship has always been of the highest order. In Holland the meeting was inaugurated by His Royal Highness Prince Bernhard in the name of Queen Juliana, in England by Her Royal Highness the Duchess of Kent in the name of King George. In Madrid, the prospective patron had been King Alfonso, but this was 1932 and on this occasion, fate took a hand. Between the inception of the Congress and its fulfillment the King had retired into exile and the new President, Alcalá Zamora graced the opening with a memorable address of welcome.

Three official themes usually dominate the scientific programs; while the presentations under these heads are by invited speakers, any member of the Congress is eligible to present a paper on a subject of his own choice, and there are sectional meetings in order to accommodate all of the speakers within the time available.

The Congresses have been extremely successful; scientific contributions are many and varied; new friendships are established and old friendships renewed. They have established a sound basis of mutual esteem and understanding by bringing together representatives of countries throughout the world for personal discussion of mutual problems.

Aside from the scientific sessions, social and cultural programs have been arranged which have included specially conducted tours to points of interest in the host city and country. Following some of the Congresses, arrangements have been made for visits to other parts of the host countries for additional special programs. These were both scientific and social in character, and were very successful additions to the Congresses.

PAUL H. HOLINGER, M.D.,
Secretary-General.

Abstracts of Current Articles

EAR

Method of Examination of the Deaf.

Ruis, M.: Rev. Otorrinolaringol. 13:43 (Apr.) 1953.

The history is of prime importance in establishing the cause and type of deafness. It should include data as to the development of the condition, its unilateral or bilateral character, the presence of concomitant buzzing sounds, echoes, or nausea, purulent aural discharge, and also a history of children's diseases, especially mumps, or of typhus, influenza, syphilis, diabetes, hypertension, cramps in the legs, tingling or coldness of the extremities, environmental factors, use of drugs (streptomycin), nervous or cardiac diseases, abortions, and familial tendencies to deafness. In addition to general examination, otoscopy is essential, to reveal obstructive wax, atresia of the passages, tumors, acute or chronic suppuration of the middle ear, sclerosis of the tympanic membrane, hemorrhages, inflammation of the labyrinth or nasopharyngeal conditions. A valuable test is insufflation by means of an Itard catheter. Pure tone audiograms and speech tests are essential.

Two thousand three hundred and ninety one cases of conduction deafness were examined and classified as follows: 784 presented otosclerosis, 114 sclerosis of the typanum, tubal obstruction was found in 45 cases, serous discharge in 55, chronic otitis media in 217, discharge from the eustachian tube in 130, otitis media associated with cholesteatoma in 56, congenital atresia in 7, and tumor of the middle ear in 2 cases.

In edema of the labyrinth the audiogram may resemble that of otosclerosis. The latter condition can be differentiated from sclerosis of the tympanum by changes in cell structure revealed by roentgenographic examination.

Perception deafness may be detected by tuning-fork tests and audiograms. In deafness of old age a characteristic finding is a gradual loss of ten decibels to the octave. In traumatic deafness the pure tone audiogram may show a decrease in tone 4096 by both air and bone conduction. The audiogram in conjunction with cardiovascular findings, study of the eye-grounds and the presence of tinnitus, slight vertigo, or a swaying sensation will establish the diagnosis.

In certain neurogenic forms of perception deafness the differential threshold may be above normal, without recruitment, associated with slight bilateral symmetric hypoacusia. Perception deafness due to lesion of the labyrinth can be differentiated from that attributable to involvement of the first neurone by audiometry and by vestibular and neuralgic symptoms. Indications of a central origin are: bilateral tinnitus associated with a gradual loss of hearing absence of recruitment, pain or duplacusis and blurring of sounds. A labyrinthine origin is suggested by: recruitment, sudden loss of hearing, pain, auditory fatigability, and diplacusis.

The nature of concomitant nystagmus is characteristic of the location of the lesion. Central nystagmus is simple, vertical, oblique, or rotatory.

Spontaneous vestibular symptoms may be observed following treatment with streptomycin. In traumatic injuries, with auricular arteriosclerosis, the loss of hearing is slight. This also applies to endotoxic, neuro-endocrine, and vagosympathetic dystonias. On the other hand, the loss is marked in edema of the labyrinth, neuritis of the eighth nerve, and involvement of the pontine-cerebellar angle, or of the lateral recess of the fourth ventricle. The neurologic findings aid in the topographical diagnosis. Serologic and cerebrospinal fluid analyses are necessary to exclude syphilis.

A few cases of deafness due to alimentary allergies have been reported.

Consanguinity of the parents may also have some bearing on hereditary forms of deafness.

HIGBEE.

Hearing Impairment and its Development Caused by Streptomycin.

Takafuji, T., and Furuya, G.: Jour. Otorhinolaryng. Soc. of Japan 56:712 (Sept.) 1953.

Authors observed hearing impairment as toxic effects of streptomycin in 50 patients with tuberculosis.

There were two groups: Group I (30 cases) were those of pulmonary tuberculosis and had been treated by intramuscular injection of streptomycin, while Group II (20 cases) were cases of tubercular meningitis having been treated by the combination of intrathecal and intramuscular injection.

Most of those in Group I (38 per cent) showed the high tone deafness in the audiogram and their degree of hearing impairment was moderate or slight.

More than half of those of Group II (59 per cent) showed total deafness.

The audiograms of Group I showed an abrupt dip at 4000 db in the beginning and later there was a gradual slope in the high tone ranges. Finally the audiogram assumed a flat form involving low and high tones.

In Group II hearing was affected rapidly for one to two months, and finally severe or total deafness developed.

From these observations the authors conclude that the primary lesion obviously begins at the end apparatus of N. cochlearis as a degenerative process and it probably proceeds to the N. acusticus in the form of "retrograde ascending degeneration."

HARA.

Clinical Investigation of Nerve Deafness Developing After Otitis Media.

Kirikae, I., and Kitayama, Y.: The Jour. of the Otorhinolaryng. Soc. of Japan 56:429 (June) 1953.

Fifty patients with nerve deafness, who had been previously well and who gave only a history of otitis media, were clinically investigated. There were two groups. In the first group nerve deafness developed immediately after the acute otitis media subsided; and in the second group this form of hearing impairment developed at some interval after the episode of otitis media.

In the first group most of the patients showed high tone deafness. This was thought to be due to tympano-labyrinthitis without any symptoms of labyrinthine irritation. In the second group most cases showed high tone deafness. In these cases the infection of the basal turn of the cochlea was suggested from the otitis media which occurred later on. Cases of nerve deafness which came on suddenly revealed a flat depression in the audiogram. The interval from the otitis media to the onset of deafness did not exceed five years in the majority of this group. Hereditary and constitutional predispositions were considered to play a part in the development of perceptive deafness. The authors emphasize the importance of treating children with otitis media as a preventive measure of deafness in adult life.

HARA.

Electrolyte Studies in Meniere's Diseases.

Perlman, Henry B., Goldinger, James M., and Cales, John O.: Laryngoscope 63:640-651 (July) 1953.

The pathogenesis of Meniere's disease or labyrinthine hydrops has not been completely explained. For many years attention has been directed to the electrolyte balance of the inner ear fluids. More recently attention has been focused on the sodium and potassium concentrations in the perilymph and endolymph.

The authors studied 15 patients with active Meniere's disease who were placed on diets that produced measured increases or decreases of serum sodium levels. The first group were given a maximum of 300 mgm of sodium, 4 to 8 grams of ammonium chloride, and mercurials to interfere with normal sodium conservation by the kidney. The second group were given diets which included up to 8 grams per day of salt and a steroid which acted on the renal tubules to cause more complete sodium reabsorption.

No consistent effects on cochlear or vestibular function were noted in patients with a measured low serum sodium and some acute severe attacks of vertigo occurred during these observations. Also no acute attacks of vertigo were seen in patients whose serum sodium had been sharply raised. No consistent deterioration of cochlear function was produced. On the contrary, a number of these patients had significant and sustained improvement of hearing during and following such treatment.

SENTURIA.

The Identification and Clinical Significance of Large Phagocytes in the Exudates of Acute Otitis Media and Mastoiditis.

Bryan, William T. K.: Laryngoscope 63:559-580 (July) 1953.

The author reports his studies on the cytology of middle ear and mastoid suppurations and describes for the first time the occurrence, in certain cases, of large phagocytic cells which he terms giant phagocytes.

As observed with the Sabin supravital staining technique, the giant phagocyte is described as follows:

The body of the cell is generally roughly spherical or oval but may be elongated and irregular. It varies in size from 20 to 50 microns in diameter. The limiting cellular membrane may be indistinct. Pseudopods are frequently seen but active motility has not

been observed. The cytoplasm may be filled with granules and vacuoles of varying size, leucocytes, red blood cells, bacteria and cellular debris. There may be two to four nuclei present and these may be spherical, ovoid or bean-shaped and are usually eccentrically located in the cell. At other times, the giant phagocytes appear as large spherical or irregular masses completely filled with smooth round globules of lipoid material. In this state the nuclei are obscured and the limiting cellular membrane is barely visible.

The giant phagocytes are readily identified with Wright stain when the smears are air-dried and not flamed. When so stained they appear vacuolated and have a foamy appearance.

Many phagocytes were found in every case of acute coalescent mastoiditis observed. Thus the author believes there is a correlation between the finding of giant phagocytes and the presence of osteitis. A study of over 2000 smears in 277 cases of otitis media and mastoiditis collected since 1933 led to the following conclusions:

(1) If no giant cells were present, recovery was not prolonged.

(2) The more giant cells present, the longer the recovery period.

(3) In a persistent discharging postoperative ear, giant cells were present as long as the infection remained alive.

(4) When the ear became "chronic," the phagocytes disappeared.

Thus the cytologic finding of giant phagocytes in the aural discharge may be an additional aid in the diagnosis and prognosis of mastoiditis.

SENTURIA.

NOSE

Chronic Paranasal Sinusitis and Allergic Reaction.

Murashima, J., and Mitsumasu, A.: The Jour. of the Otorhinolaryng. Soc. of Japan 56:591 (Aug.) 1953.

In 27 cases of chronic paranasal sinusitis the authors examined the occurrence of allergic diseases in past and family histories, presence of nasal polyps, edematous swelling of the turbinates, eosinophilia in the nasal secretion and blood, the positive allergic reaction of the skin, eosinophilic infiltration and edema of the mucous mem-

brane of the sinus, fibrinous degeneration in the wall of blood vessels, etc. According to these authors these studies did not yield consistent results and a definite relationship between allergy and paranasal pneumatization was not proved. Clinical diagnosis of allergic paranasal sinusitis was difficult to establish.

HARA.

Fifteen Cases of Caseous Paranasal Sinusitis and a Consideration of the Cause of this Disease.

Osawa, R., and Nakamura, Y.: The Jour. of the Otorhinolaryng. Soc. of Japan 56:608, 1953.

The authors treated 15 cases of caseous paranasal sinusitis of which 4 were of mild type and the others were of severe type, according to Texier's classification. Six of them were between the ages of 50 to 60 years. Eight had involvement in the maxillary sinus.

Foul rhinorrhea, headache and granular transformation on the wall of the middle meatus were pronounced in the severe type of this disease. In most cases appearance of the infected sinus in x-ray photographs was dark. Destruction of the inner wall of the maxillary sinus and the septa of ethmoid cells was frequently found. The differentiation between carcinoma of the maxillary sinus and this type of suppurative paranasal sinusitis is stressed. They pointed out a few important criteria for differential diagnosis.

From the history, clinical, pathological and bacteriological findings the following clues to the etiology of this disease were mentioned. The mild type of this disease should be considered as an atypical form of chronic paranasal sinusitis. The acute, progressive and destructive nature and the presence of mixed infection found in severe cases support the view that it may be different from the mild type and caused by some bacteria. In four cases of the severe type abundant spirochetes and fusiform bacteria were found. Analysis of the caseous substance showed content of whole cholesterol as high as 0.39 per cent. The authors consider that these are important factors in the development of the severe type of caseous paranasal sinusitis and destruction of bone tissue.

HARA.

THROAT

Surgical Technique Facilitating Radium Therapy in Cancer of the Base of the Tongue.

Serra, R. M., and Gutierrez, G. C.: Rev. Cubana Oto-Tino-Laringol. 2:5:47.

The frequent incidence of epitheliomas of the base of the tongue, and the danger of infiltration into the upper respiratory and digestive tracts as well as the muscles of the tongue, render roentgenotherapy and surgery difficult, if not impossible. The most effective treatment is interstitial implantation of radium, to which these tumors are especially vulnerable.

The suggested procedure provides a wide operative field, good visualization of the lesion, ready access, reduction of operative time, and correct distribution of the therapeutic agent.

Access is by transverse section of the cheek as far as the anterior border of the masseter muscle, below Stensen's duct, under endotracheal anesthesia. The lower portion of the pharynx is packed, and the borders of the buccal commissure are held back by coarse sutures. The tongue is immobilized by means of clip forceps or suture, under slight traction, to afford good visualization of the posterior portions. After the small blood-vessels are ligated, the radium tubes, tied with coarse cotton thread, are then inserted, and held in place with fine sutures. The cotton threads are attached to the outer skin of the face, by adhesive tape and the surgical wound is then sutured. The procedure does not endanger Stensen's duct or affect the motility of the facial skin.

A case is cited of a man 74 years old who had had pain in the posterior left gingival region for approximately a month, followed by diffuse pain in the neck and left ear, inflammation of the throat, and loss of weight. Examination revealed an infiltrating tumor at the base of the tongue on the left side, extending almost to the glossoepiglottic sulcus. There was slight bleeding, but no involvement of the lymph glands. Biopsy showed the tumor to be epidermoid epithelioma.

Employing the technique described above, two 2 mg radium tubes were inserted and kept in place for 100 hours, amounting to 6,000 r to 8,000 r, which is considered to be the optimal dosage. The tumor decreased in size within a week. After 15 days only an indurated zone of scar tissue remained, and the tumor had disappeared. A routine examination six months later revealed no evidence of neoplasm, and only a barely perceptible facial scar.

HIGBEE.

LARYNX

Laryngeal Cancer and Its Surgical Treatment.

Loli, E., and Loli, M.: Rev. Peruana Otorrinolaringol. Oftalmol. 2:4, 41 (July) 1953.

Laryngeal cancer is usually fatal unless recognized and treated early. Surgical treatment and recovery are facilitated by easy access to the lesion, the fact that the larynx can be removed, the relative lack of lymphatic vessels, and the location of the lymph nodes which are sources of metastasis.

Predisposing factors of cancer are chronic inflammation, vocal abuse, and constant irritation due to tobacco or alcohol. The most frequent site is the middle or anterior third of the vocal cord. The growth develops slowly, due to the histologic characteristics of the stratified epithelium, and may not involve underlying tissues. It may, however, extend to the anterior commissure, less frequently to the posterior segment, downward to the glottis or upward to the ventricular ligaments, the epiglottis, and lower portion of the pharynx. The primary symptom of intrinsic cancer may be loss of normal vocal clarity, sometimes noticeable only when the voice is strained, but progressing in severity and sometimes resulting in complete aphonia. Infiltration and superimposed infection cause a persistent dyspnea. The initial symptoms of extrinsic cancer are hoarseness, slight pain radiating into the neck, which is increased by swallowing. Later the lymph nodes become palpable, especially those above the hyoid bone, and the general condition of the patient deteriorates. The dyspnea and dysphonia characteristic of the intrinsic type are late symptoms of extrinsic cancer, and are usually noted after exertion or prolonged use of the voice.

Laryngoscopy will reveal swelling, infiltration, possibly fungoid ulceration, polyps or papillomas, which are usually sessile. Decrease in motility of the cord is charactristic. Radiographic examination, and biopsy, are essential to confirm the differential diagnosis and to exclude syphilis and tuberculosis. Specific lesions are prone to localize on the epiglottis and produce ulceration and necrosis surrounded by an inflammatory zone. The presence of other signs of syphilis, and serologic reactions, establish the diagnosis, but do not exclude the presence of cancer as a concomitant condition.

Tuberculosis has a predilection for the arytenoid or interarytenoid regions. These lesions are characterized by pallor or bluish color of the mucosa. Radiographs of the chest may establish the diagnosis.

Scleroma of the larynx can be detected by crusts and inflammation of the cord, small, pale granulomas, cicatricial stenosis, and by the presence of nasal and pharyngeal lesions.

Laryngeal leishmaniosis can be differentiated only by the presence of primary cutaneous lesions and secondary involvement of nasopharyngeal areas, and laboratory findings.

Mycosis results in disseminated, violet-colored, ulcerated granulomas. Biopsy establishes the differential diagnosis.

Each case of cancer requires individual treatment, but total extirpation of the lesion and surrounding tissue and lymph nodes is essential. Surgical removal is safer than roentgenotherapy. The authors employ a modified laryngectomy technique (Crowe) which avoids the danger of necrosis due to slow healing and trauma. A description of the operation is given.

There were no postoperative fatalities. Only one case of aspiration pneumonia has been observed. The most common complication is fistula of the pharyngeal wound, necessitating plastic repair.

By forcing air from the stomach through the neopharynx and oronasal cavity most patients are able to develop an esophageal voice which is comprehensible.

Of thirty patients operated upon by this technique, five died due to metastasis or acute atelectasis. In the other cases the survival times were from four months to eight years.

HIGBEE.

BRONCHI

Bronchogenic Carcinoma.

Jack, Gordon D.: Edinburgh Med. Jour. 60:75-86 (Sept.) 1953.

In order to emphasize the early diagnosis of primary carcinoma of the lung, the incipient signs and symptoms of cases seen on the Thoracic Unit at the University of Edinburgh between May, 1946, and December, 1951, were analyzed and reviewed. Cough was the most frequent symptom and was present in 95 per cent of the cases when first seen. This was described as dry or associated with a trace of morning sputum, the patient usually attributing it to his smoking habit. Blood-stained sputum was noted as a first symptom in only 8.8 per cent of cases, but on hospital examination was present in almost one-half the cases.

Next to cough and sputum, thoracic pain was the most frequent first symptom (59 per cent of patients) and was felt in the chest wall over the broncho-pulmonary segment involved. Febrile episodes were very frequent, occurring in half the patients. Under chemotherapy, recovery was rapid for a time, the cough diminishing and the sputum either disappearing or becoming mucoid.

It is noteworthy that mass radiography did not result in the discovery of many early or asymptomatic cases.

Almost 90 per cent of the cases were males with over 90 per cent between the ages of 41 and 70. A simple clinical examination often revealed few or no abnormal signs but x-ray of the chest, including a lateral, was considered necessary. Radiologically, segmental collapse of one or two pulmonary segments was observed in 24 per cent of the cases and such a sign is so typical of bronchogenic carcinoma and so often associated with a bronchoscopically visible tumor that it constitutes a most valuable feature in the case work-up. However, the majority of early tumors did not produce a diagnostic shadow but were associated with a small area of diminished translucency liable to be diagnosed as segmental pneumonia.

These symptoms and x-ray findings are an indication for bronchoscopy including the use of telescopes which enable most of the segmental orifices to be seen. Histologic verification of tumors situated beyond bronchoscopic vision may be obtained by examination of secretions aspirated from the segmental bronchi concerned. Under these conditions the author believes that the diagnosis of bronchogenic carcinoma can be established in about three-fourths of the cases in which it is present.

Six hundred and sixty-eight cases were seen on the Unit. Four hundred and sixteen patients were found unsuitable for operative treatment. Thirty-two patients refused investigation or died before admission to the hospital. Thoracotomy was carried out in 220 cases. Resection was abandoned in 53 cases, primarily because of invasion of the heart or pulmonary artery. Pulmonary resection was possible in 167 cases with an early postoperative mortality of 18 per cent.

Although it is too early to assess the results, out of the 327 patients seen before 1950, only 62 underwent surgical resection and 15 or 4.6 per cent of all the patients and only one-fourth of those undergoing resection were alive two and one-half years later.

The author concludes that cases must be found early. If resection of the tumor together with the lung and adjacent glands is possible, he feels that resection offers the best chance of cure. In all cases major surgery should be avoided.

SENTURIA.

ESOPHAGUS

Acth (Adrenocorticotrophic Hormone) and Cortisone in the Treatment of Esophageal and Gastric Lesions Caused by the Ingestion of Caustics.

Tellez, R., Pelaez, P., Basterrica, A., and Grez, A.: Rev. Otorrinolaringol. 13:1.65 1953.

A case is cited of a boy eighteen years old who accidentally swallowed caustic soda. There was immediate vomiting, bleeding, and intense burning pain in the mouth, esophagus, and pharynx. Lemonade was given as an antidote, and the stomach was washed out with physiologic saline solution. The esophagus was dilated with a Hurst mercury sound twice a day for six days. At this time a stricture developed in the lower portion of the esophagus, so that the sound could not be introduced. This continued for ten days. The severe pain prevented swallowing anything but liquids. The administration of 50 mg of ACTH daily from the eleventh to the fifteenth day after the accident decreased the pain and dysphagia, so that the patient was able to swallow bland solid foods.

As the stenosis could not be reduced, gastrostomy was necessary, followed by retrograde dilatation with sounds for five days. However, hemorrhage of the esophagus, and fever, developed, necessitating cessation of the treatment. ACTH was again given for 21 days, in doses ranging from 40 to 100 mg daily, in conjunction with potassium chloride and vitamin C. This resulted in rapid decrease in pain, so that the patient was again able to swallow food. It was then possible to introduce a No. 36 sound. The psychic depression which followed suspension of the hormone treatment was relieved by benzoate of estradiol and propionate of testoserone. Except for occasional recurrences of the stenosis, with difficulty in deglutition during emotional excitement, recovery has been complete.

Esophagoscopy 25 days after the ingestion of the caustic revealed granulations, fibrinous exudate, and bleeding. The stenosis and subsequent recovery were checked at intervals by roentgenographic examinations.

The benefit derived from hormone treatment in such cases is due to the anti-inflammatory and antifibroblastic action of the ACTH, which decreases the cicatricial fibrosis and consequent stenosis.

The caustic may result in superficial or deep ulceration, and the formation of scar tissue so firm as to resist dilatation. The severity of the lesions depends upon the nature of the caustic and the amount ingested. Alkaline caustics generally produce lesions of the esophagus, but not of the stomach, due to the neutralizing effect of the acid gastric juice.

Acid caustics attack the digestive tract, from mouth to pylorus. The difficulty in swallowing food results in nutritional deficiency and cachexia. The mortality rate is high, unless dilatation with a mercury sound is carried out successfully soon after the accident.

The author treated 20 patients who had swallowed acid caustics (18, hydrochloric acid, 1, nitric acid, 1, sulfuric acid). Initial treatment consisted in antibiotics, especially penicillin, in doses of 500,000 units every eight hours for five to six days, parenteral administration of fluids, sedatives, and analgesics. This was followed by cortisone in 18 cases and by ACTH in two cases. The latter is more effective as an antifibroblastic agent. The earlier the hormone treatment can be begun the better the results. Dosage is 150 to 200 mg daily of cortisone, or 100 mg daily of ACTH, for from ten to fifteen days or longer, depending upon the severity of the condition. This is gradually reduced, and is discontinued at the end of about thirty days.

The complications inherent in hormone therapy (edema and swelling of the hands and face, excessive perspiration, psychic stimulation) are counteracted by potassium chloride, in the dosage of 1 to 2 gm daily, restriction of salt in the diet, and 500 mg of vitamin C daily.

Dilation with the Hurst sound is begun as soon as possible, and is continued twice daily for two to four months. Esophagoscopy is not advisable during the first few days, for fear of rupturing the delicate, newly-formed superficial layer of scar tissue, and causing hemorrhage.

In general, results have been gratifying. The toxic condition and local symptoms respond to hormone therapy promptly.

HIGBEE.

MISCELLANEOUS

Optokinetic Nystagmus and Posture.

Fukuda, S., Hinoki, M., Tokida, T., Oku, K., Yanagihara, R., and Nakagawa, Y.: Otolaryngology (Japan) 25:577 (Oct.) 1953.

Optic stimulation causing vertigo and falling has been previously presented by various authors. The present study is concerned with the measures of nystagmus influenced by various postures assumed by individuals.

Fukuda, et al, used a rotation drum two meters in diameter and 1.7 meters in height, suspended from above. The drum had 16 vertical red stripes, evenly distributed. They were 3 cm wide, marked on the white inner surface. The drum rotated at the speed of one rotation in 10 seconds, either to right or left. Below the drum was a two-meter disc upon which stood the subject to be tested. The disc was also divided into 16 equal sections. When the subject was placed on the disc and the drum rotated he developed nystagmus. Using this phenomenon as the basis of the experiment, the following tests were conducted.

Sixty seven normal adults were tested by placing each in the center of the drum with and without wearing a head-band. This head-band held an apparatus with a small mirror supported on a metal rod, 30 cm in front of the subject's head for the purpose of fixation of his eyes. Then the disc turned at the speed of one turn every 10 seconds and at the same time the subject was told to keep stepping during a period of 50 seconds. Since the eyes were fixed on the otogoniometer and the disc kept moving there was a strong ocular stimulation. When the subject did not wear the otogoniometer and the disc turned at the same rate of speed, he developed a violent nystagmus.

With fixation of the subject's eyes, he experienced vertigo twice as strong as without fixation and his steps were about one-half as many before falling in the direction of the rotating drum. When the subject assumed such a posture as in bending the body forward, or stooped low so as to support his torso with both legs and arms (bear-like) he developed less nystagmus and experienced a lesser degree of vertigo as compared with the natural standing posture.

HARA.

Books Received

Grenzen des Normalen und Anfange des Pathologischen im Rontgenbilde des Skelette. (Borderline Between the Normal and the Beginning Pathological in Roentgenograms of the Skeleton.)

By Dr. A. Köhler, Ninth Edition completely revised in text and illustrations by Dr. E. A. Zimmer, Bern/Fribourg. Large 8 vo., cloth, xii+672 pp., 1282 illus. Georg Thieme, Stuttgart, 1953.

This monumental ninth edition of a long established text, first published in 1910, is primarily a reference work for the radiologist and the medical library. Seventy-six informative pages are devoted to the skull, however, and contain some very useful material for the otolaryngologist. Directed as it is to the early stages of disease it contains some rather special information and roentgenograms not often found in the standard texts. (In German)

Ear, Nose and Throat Diseases. (For Medical Students)

By William McKenzie, M.B., B.Chir. (Cantab.) F.R.C.S. (Eng.), Surgeon, Royal National Throat, Nose and Ear Hospital; Surgeon Ear, Nose and Throat Department, Prince of Wales Hospital, Tottenham. vii+260 pp., 8 vo., cloth, illustrated, 1953. E. and S. Livingstone, Ltd., Edinburgh and London (Available through Williams and Wilkins Co., Baltimore in the United States). (Price $5.50).

Cytodiagnosis in Pulmonary Cancer. The Significance of a Cytological Examination of Sputum and Bronchial Secretion in the Diagnosis of Pulmonary Cancer.

By Lars Hjelt, Department of Pathology of the University of Helsinki, Finland, Volume 42, Supplement 3 of the Annales Chirurgiae et Gynaecologiae Fenniae, 68 pages, paper, 1953.

On the Distribution of the Lymphatics of the Human Larynx. (Sulla Fine Distribuzione dei Vasi Linfatici della Faringe Umana)

By G. C. Vidoni and G. Maffei, from the Institute of Normal Human Anatomy and the Otolaryngological Clinic of the University of Parma. Supplement XV, 1953, of the Archivo Italiano di Otol. Rinol. e Laryngol. Paper, pp. 87.

The Antibiotics in Otorhinolaryngology (Los Antibioticos en Otorrinolaringologigia).

By Ernesto Alonso Ferrer, M.D., Madrid, Spain. Royal 8 vo., cloth, illustrated. Raigal - Doctor Castelo, 8, Madrid, 1953.

A brief and fairly comprehensive review of the literature of the antibiotics as applied to the ear, nose and throat. It includes the characteristics and dosages of the more important antibiotics, and their relative toxicities. (In Spanish)

Dizziness. An Evaluation and Classification.

By David Downs DeWeese, M.D., Clinical Professor of Otolaryngology University of Oregon Medical School. Pp. 80, illustrated, Charles C. Thomas Company, Springfield, Illinois, 1954. (Price $2.75)

Notices

XIXTH INTERNATIONAL CONGRESS OF OTO-NEURO-OPHTHALMOLOGY

The XIXth International Congress of Oto-Neuro-Ophthalmology will be held in São Paulo (Brazil), from June 11th to 17th, 1954.

Inquiries or suggestions about the Congress should be addressed to:

Clínica Oftalmológica
Hospital das Clínicas
São Paulo, Brazil.

FOURTEENTH JAPAN MEDICAL CONGRESS

The Fourteenth Japan Medical Congress will be held in Kyoto, April 1-5, 1955. Particulars may be had of the Secretary General, Mitsuharu Goto, University Hospital Kyoto University, Kyoto, Japan.

UNIVERSITY OF ILLINOIS

The next Bronchoesophagology Course to be given by the University of Illinois College of Medicine is scheduled for the period March 22 through April 3, 1954. The course is under the direction of Dr. Paul H. Holinger.

Interested registrants will please write directly to the Department of Otolaryngology, University of Illinois College of Medicine, 1853 West Polk Street, Chicago 12, Illinois.

AMERICAN LARYNGOLOGICAL ASSOCIATION

Copies of the Transactions of the American Laryngological Association are available for general distribution at $8.00 a copy. Please send request with check to:

Dr. Bernard J. McMahon,
Editor Transactions
8230 Forsyth Blvd.
Clayton 24, Mo.

IV INTERNATIONAL CONGRESS

There are a few copies of the Proceedings of the 4th International Congress of Otolaryngology still available for purchase.

The publication contains all of the numerous papers, and is well produced. Copies may be had, at Five Guineas, from

The Secretary
British Medical Journal
B. M. A. House
Tavistock Square
London, W. C. 1.

PAN-AMERICAN SURGICAL ASSOCIATION

Doctors are cordially invited to attend the Sixth Congress of the Pan-Pacific Surgical Association to be held in Honolulu, October 7-8, 1954.

For further information, please write to F. J. Pinkerton, M.D., Director General, Pan-Pacific Surgical Association, Suite 7, Young Building, Honolulu, Hawaii.

AMERICAN LARYNGOLOGICAL ASSOCIATION

CASSELBERRY PRIZE

A sufficient sum having accrued from the Casselberry Fund for encouraging advancement in the art and science of Laryngology and Rhinology, this sum is now available, in part or as a whole, for a prize award. Theses must be in the hands of the Secretary, Dr. Harry P. Schenck, 326 South 19th Street, Philadelphia, Pa., before March 1, 1955.

TULANE UNIVERSITY OF LOUISIANA
SCHOOL OF MEDICINE

The three year residency in otolaryngology offered at Charity Hospital of Louisiana at New Orleans on the Tulane University of Louisiana School of Medicine service is designed to qualify the holder for the examinations of the American Board of Otolaryngology and the practice of all phases of otolaryngology and endoscopy.

Candidates must be graduates of a class A medical school and must have completed a minimum of one year of general internship. An additional year of residency in internal medicine or general surgery is desirable but not essential.

All work is under the direct supervision of members of the Tulane Department of Otolaryngology, who are also members of the Charity Hospital Otolaryngological Staff; they are available at all times for instruction and guidance. Basic sciences are offered throughout each year of the residency during the academic year. The resident also participates in the program of the Speech and Hearing Center at the Tulane University School of Medicine.

The hospital year extends from July 1 of one year to June 30 of the following year.

Applications should be addressed to the Chairman of the Department of Otolaryngology, Tulane University of Louisiana School of Medicine, 1430 Tulane Ave., New Orleans 12, Louisiana.

UNIVERSITY OF PENNSYLVANIA

Announcement is made of the personal fundamental course in Bronchology, Esophagology, Gastroscopy and Laryngeal Surgery at the Graduate School of Medicine, University of Pennsylvania. The course begins September eighth and continues through September nineteenth.

Courses are scheduled usually in January, June and September avoiding conflict with the meeting dates of the National Medical Societies.

Application may be made to Dr. Aims C. McGuinness, Dean, or to Dr. Gabriel Tucker, Chairman of the Department of Bronchology, Esophagology, and Laryngeal Surgery.

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President: Dr. Derrick Vail, 700 N. Michigan Blvd., Chicago 11, Ill.
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American Board of Otolaryngology

President: Dr. Frederick T. Hill, Professional Bldg., Waterville, Maine.
Secretary: Dr. Dean M. Lierle, University Hospital, Iowa City, Iowa.

American Broncho-Esophagological Association

President: Dr. Edwin N. Broyles, 1100 N. Charles Street, Baltimore, Md.
Secretary: Dr. F. Johnson Putney, 255 S. 17th St., Philadelphia 3, Pa.
Meeting: Statler Hotel, Boston, May 25th and 26th, 1954.

American Laryngological Association

President: Dr. Gordon F. Harkness, 2410 River Drive, Davenport, Iowa.
Secretary: Dr. Harry P. Schenck, 326 South 19th St., Philadelphia, Pa.
Meeting: Boston, Mass., May 28 and 29, 1954.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. Francis LeJeune, Prytania and Olive Sts., New Orleans, La.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.
Meeting: Boston, Mass., May 25-27, 1954.

American Medical Association, Section on Laryngology, Otology and Rhinology

Chairman: Dr. Carl H. McCaskey, 20 N. Meridian St., Indianapolis, Ind.
Secretary: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis 3, Tenn.

American Otological Society

President: Dr. Frederick T. Hill, Professional Bldg., Waterville, Maine.
Secretary-Treasurer: Dr. John R. Lindsay, 950 East 59th St., Chicago 37, Ill.
Meeting: Boston, Mass., May 23 and 24, 1954.

The American Society of Ophthalmologic and Otolaryngologic Allergy

President: Albert D. Ruedemann, M.D., Detroit, Mich.
Secretary-Treasurer: Michael H. Barone, M.D., Buffalo, N. Y.
Meeting: New York City, September, 1954.

VI International Congress of Otolaryngology

President: Arthur W. Proetz, M.D., St. Louis, U. S. A.
Secretary-General: Paul H. Holinger, M.D., 700 North Michigan Ave., Chicago 11, Ill., U. S. A.
Meeting: 1957.

International Bronchoesophagological Society

President: Dr. Andre Soulas, Paris, France.
Secretary: Dr. Chevalier L. Jackson, 1901 Walnut St., Philadelphia 3, Pa., U.S.A.
Meeting: Third International Congress of Bronchoesophagology, September or October, 1954, Lisbon, Portugal.

Pacific Coast Oto-Ophthalmological Society

President: Leland G. Hunnicutt, M.D., 98 N. Madison Ave., Pasadena 1, Calif.
Secretary-Treasurer: John F. Tolan, M.D., 3419 47th Ave., N.E., Seattle 5, Wash.
Meeting: Honolulu, 1954.

Pan-American Association of Oto-Rhino-Laryngology and Broncho-Esophagology

President: Dr. Justo M. Alonso, Montevideo.
Secretary: Dr. Chevalier L. Jackson, 1901 Walnut St., Philadelphia 3, Pa., U.S.A.

Canadian Otolaryngological Society

President: Dr. Robert Black, 401 Medical Arts Bldg., Winnipeg, Manitoba.
Secretary: Dr. W. Ross Wright, 361 Regent St., Fredericton, N. B.
Meeting: Harrison Hot Springs Spa, Harrison Hot Springs, B. C., June 13th to 15th, 1954.